POWER PLANT ENGINEERING

Trade-mark reg. U. S. Pat. Office

VOL. XXIII. CHICAGO, JULY 15, 1919 No. 14

U. S. Nitrate Plant No. 2

FIRST ARTICLE IN A SERIES OF TWO DESCRIBING 10,000-KW. STEAM STATION AT MUSCLE SHOALS BUILT FOR WAR PURPOSES. BY EDWARD R. WELLES AND W. A. SHOUDY*

THE UNITED STATES Nitrate Plant No. 2, situated at Muscle Shoals, Alabama, receives its power from a steam generating station which in many respects is of exceptional interest to the engineering world. It is perhaps the largest generating station erected as a complete unit and is undoubtedly the largest to supply a single industrial plant. It promises to rank with the most economical stations, possibly surpassing any in continuous operating costs and has a remarkable record in time of construction. The signing of the armistice found this station nearly ready for operation, 283 days after breaking ground; hot clearances having been taken on one element of the turbine and enough boilers having been completed to operate this element. The sudden change in labor conditions and hours of labor following the armistice immediately slowed the schedule, making the rate of progress much less than obtains in private enterprise, hence the exact time in which this station would have been completed will never be accurately known.

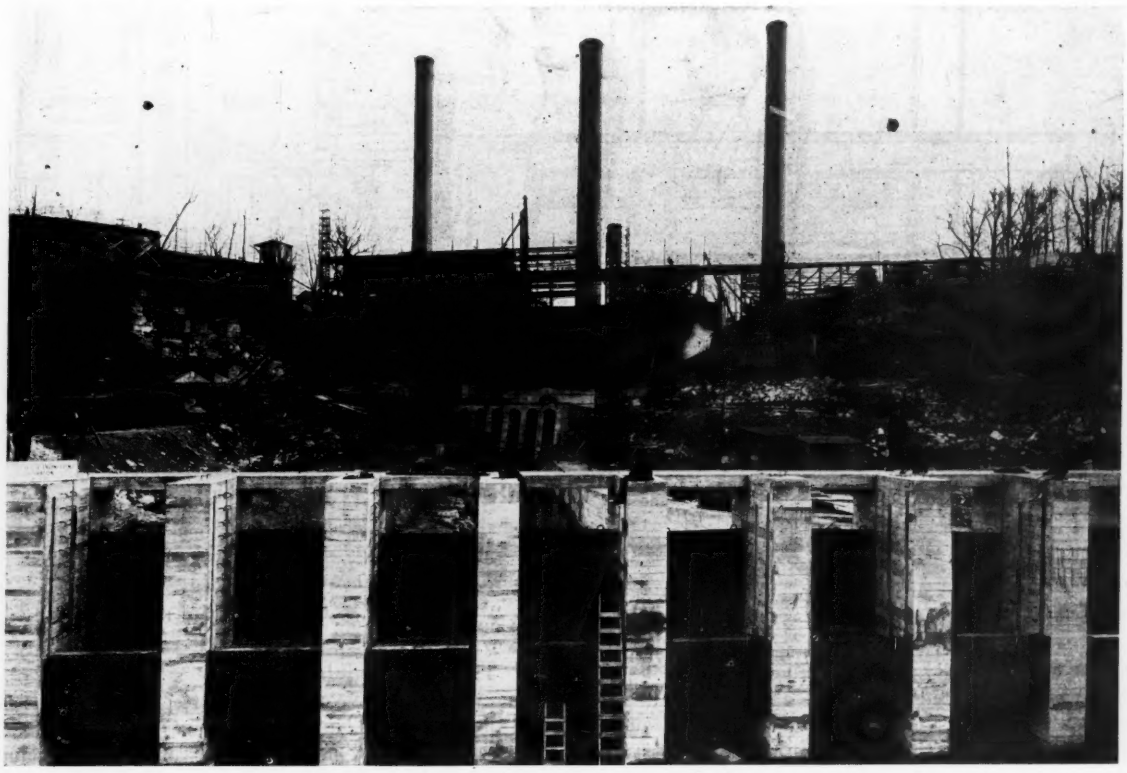


FIG. 1. U. S. NITRATE PLANT NO. 2 UNDER CONSTRUCTION; CIRCULATING WATER INTAKE IN FOREGROUND SHOWING FLOATING TRASH SCREEN AND STOPLOGS

Nitrate Plant No. 2 is designed to operate with the cyanamid process. The Air Nitrates Corporation, a subsidiary of the American Cyanamid Co., was organized to construct and operate the plant under contract with

* Mechanical Division, J. G. White Engineering Corp.

the U. S. Army Ordnance Department. The J. G. White Engineering Corporation designed and erected the steam-electric generating station and Westinghouse, Church, Kerr & Co. erected the industrial buildings, the largest of their respective kinds in the world; the whole project covering about 2200 acres.

An electric load of between 70,000 and 80,000 kw. is required by the process. Since the greater part of this is furnace load, the station load factor will approximate

In the summer of 1918, it was decided to install an additional generating unit. Additional boilers were purchased and plans prepared for the extension of the boiler house to include this unit. The unit, however, was not definitely selected and upon the signing of the armistice its installation was abandoned and the boilers and building extension canceled. This unit would probably have been about 27,000 kw. capacity at 85 per cent power factor with a 30,000 maximum.

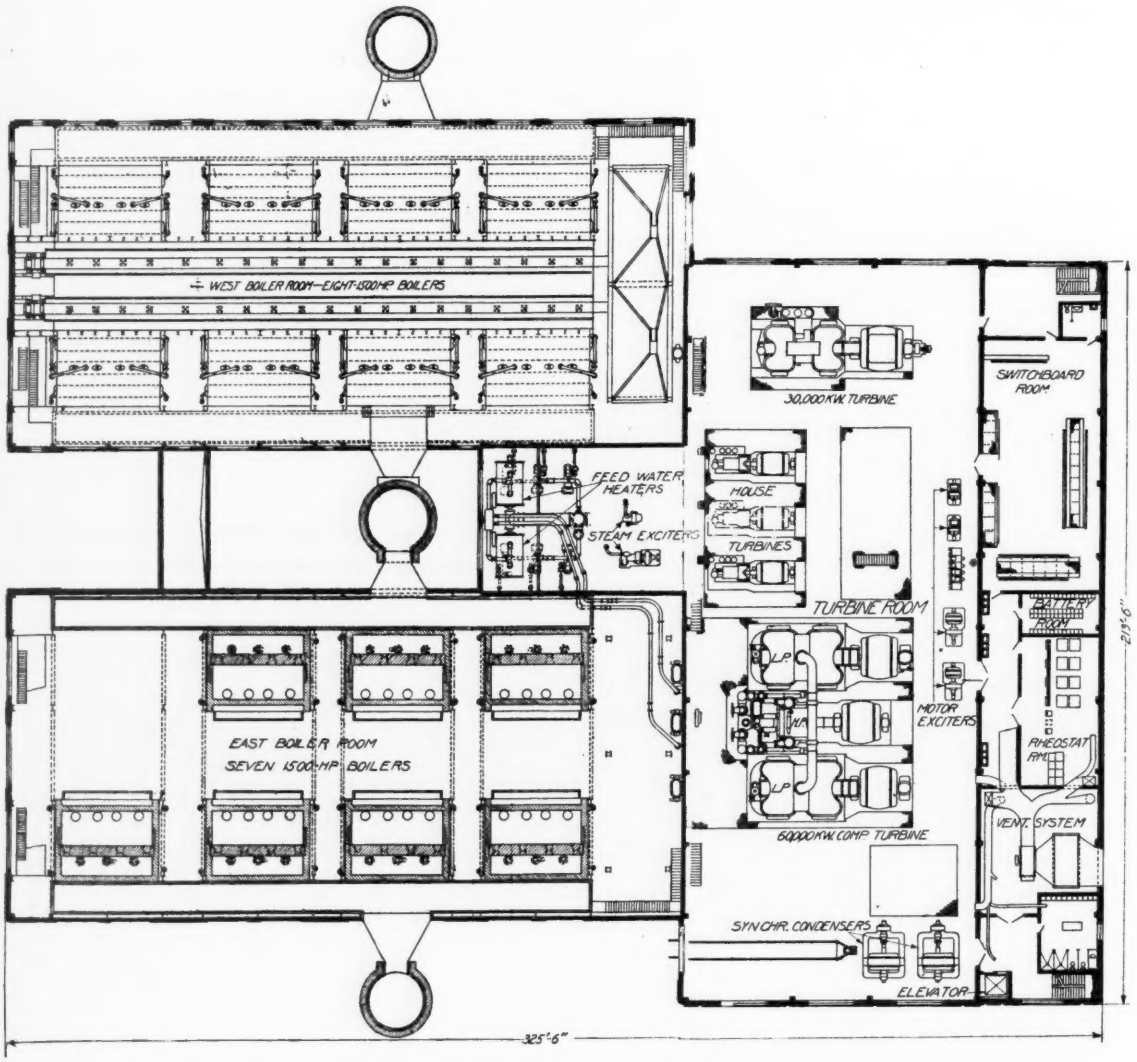


FIG. 2. MAIN FLOOR PLAN OF POWER HOUSE

90 per cent annually. A transmission line about 85 mi. long was constructed to provide about 20,000 kw. from the Alabama Power Co.'s system. The load required of the steam station is therefore about 55,000 kw. The generating unit now installed is one of the two largest in the world, the other being in the 74th St. Station of the Interborough Rapid Transit Co., New York. They differ, except for minor details, only in that the Interborough generators are 25 cycles and the Nitrate, 60 cycles, and of higher speed in the high-pressure element. The turbine is a three-element compound Westinghouse turbine having a capacity of 60,000 kw. at 85 per cent power factor and a two-hour capacity of 70,000 kw.

The industrial buildings are situated on a plateau about 125 ft. above the Tennessee River. The bluffs lining the south banks of the river are broken at four places by narrow ravines, these four ravines being the only points giving access to the river. Ravine No. 3 appeared to offer the fewest construction difficulties, hence was chosen for the station site. This ravine was about 50 ft. wide just above extreme low water (El. 398) and about 140 ft. wide at high water (El. 435) and had a total width of about 1000 ft. at the plateau level (El. 525) widening into an irregular form back from the river. The first construction work was the throwing of a short coffer dam across the ravine at the river edge,

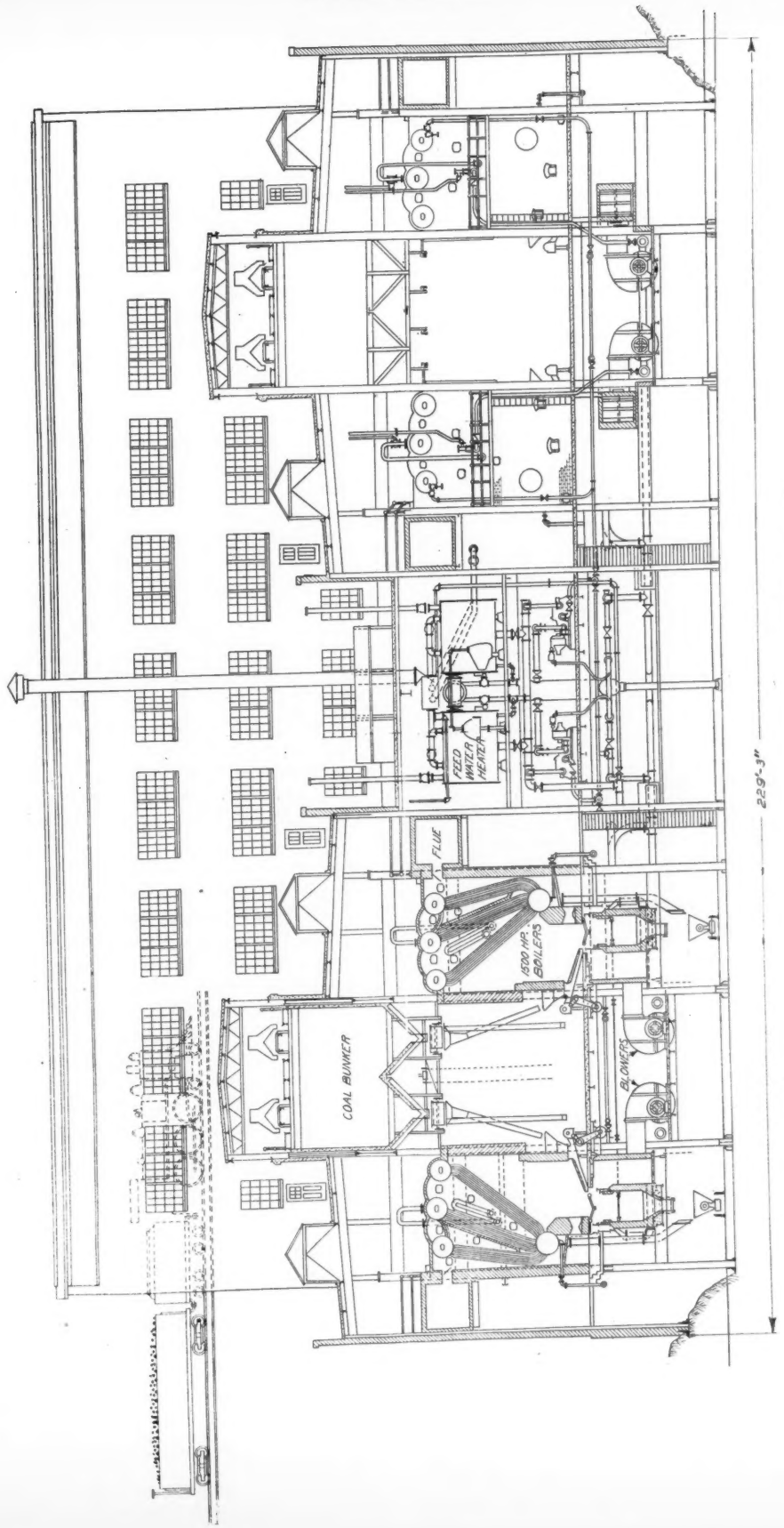


FIG. 3. LONG SECTION OF BOILER ROOM, NITRATE PLANT NO. 2

thus protecting the work of excavating during possible high water. The station was protected against high water by building the river wall exactly as a dam, thus avoiding the necessity of constructing the very heavy walls and floors for the substructure that would have been necessary had the entire structure been subject to hydrostatic pressure during high water. The natural bed of the ravine was cleaned out to provide an intake channel and the circulating pumps located directly over this bed thus eliminating excessive excavation.

All coal is received by railroad at the elevation of the plateau. A standard gage track was therefore extended directly over the station building. Coal is unloaded into track hoppers whence it runs by gravity to the crushers

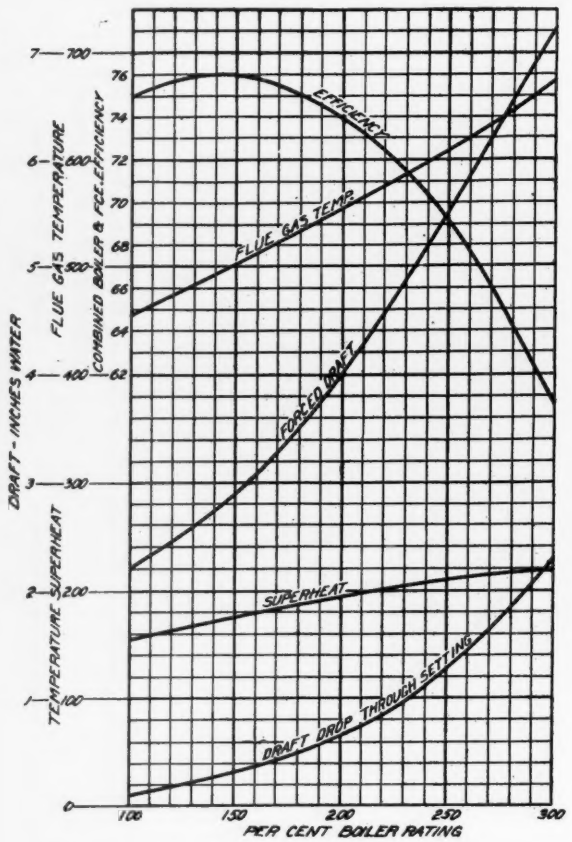


FIG. 4. BOILER AND STOKER CHARACTERISTICS

and is delivered to the overhead bunkers in the boiler house by belt conveyors, thus eliminating all elevators. The unloading trestle crosses the narrowest part of the ravine and is between the boiler and turbine rooms, thereby providing the necessary aisle between the two rooms and permitting the extension of the station without disturbing the coal unloading apparatus.

To avoid possible delay due to the excessive demand for steel plates and steel products, only brick stacks were considered. By erecting these outside the buildings, it was possible to erect them without interference with the erection of the buildings. The logical arrangement of the boiler room was therefore in two buildings as shown. This arrangement also permitted the complete erection of one boiler room and its operation without interference during the completion of the other.

The V-shaped building resulting from this design permitted the construction of a U-shaped gallery below the firing floor, in which the forced draft fans were installed, on the floor of which gallery were placed the main steam and feed water headers, giving immediate access to all principal piping and valves. The steam exciters, the feed pumps and the feed-water heaters were installed in the area between the two boiler houses and adjoining the turbine room, thus placing all steam operated machinery at one level and within the direct control of the watch engineer. Directly above the feed pump

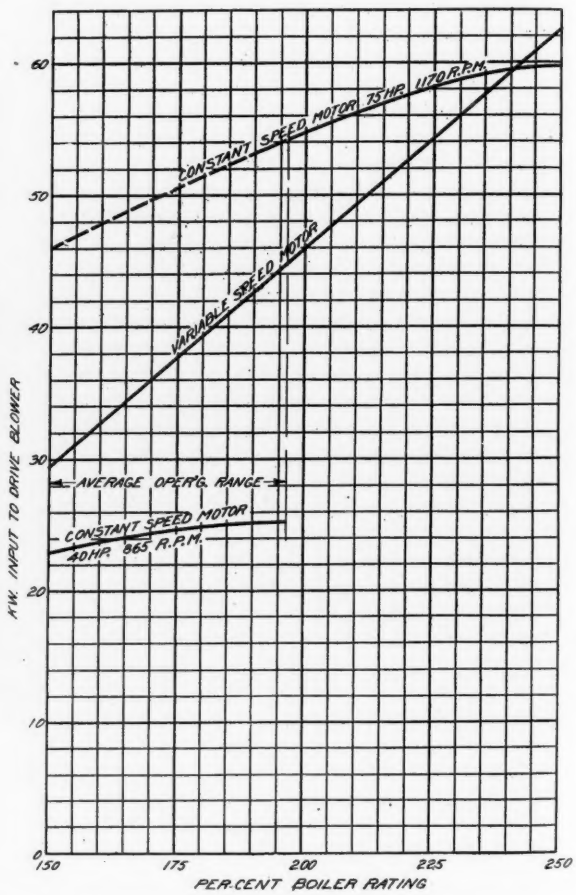

K.W. INPUT TO DRIVE BLOWER
CONSTANT SPEED MOTOR 75 HP. 1170 R.P.M.
VARIABLE SPEED MOTOR
AVERAGE OPER'G. RANGE
CONSTANT SPEED MOTOR
40 HP. 865 R.P.M.
PER CENT BOILER RATING

FIG. 5. COMPARISON OF MOTOR DRIVES FOR FORCED DRAFT BLOWERS

room is the chief engineer's office, in the geographical center of the station. A bayed window in this office gives a view of the entire turbine room and exits give immediate entrance to turbine room, heater room and both boiler rooms. The recording mechanism of the venturi feed-water meters and condensate meters is installed in this room, together with other instruments for keeping in close touch with the operating economy of the station.

Station Auxiliaries

All station auxiliaries with the exception of the boiler feed pumps and steam exciters are electric driven.

The auxiliary power is generated by two Westinghouse noncondensing turbo-generators (2000 kw. at 80 per cent power factor) each of which may carry the entire auxiliary load.

The cyanamid process requires for its operation between 30,000,000 and 40,000,000 gal. of water per day. The pumps to supply the water are located in the circulating pump pit. These pumps are motor driven and connected to the auxiliary bus, which is also connected through transformers to the main bus. Power for these pumps may therefore be taken from either the auxiliary, or house turbines, or from the main generating unit.

At the average station load, 55,000 kw., about 2000 kw. is required for excitation and all station auxiliaries. At this station load, the exhaust steam required from the house turbines for heating the feed water, in addition to that from the feed pumps, is an amount equivalent to that discharged when the turbines are generating about 2400 kw. The process water pumps require about 700 kw., hence 4/7 of this pumping load may be carried by the house turbines with just sufficient exhaust to heat the feed water and at a cost of less than 3500 B.t.u. per kw.-hr. One house turbine will be operated continuously at about 1400 kw., which is near the load of greatest economy and the load of the other turbine will be controlled by the pressure of the auxiliary exhaust automatically shifting the pumping load between the auxiliary bus and the main bus in accordance with the demand for steam for feed-water heating. Careful study has shown slightly better economy with the auxiliary exhaust at 5 lb. gage than at a lower pressure. A still higher back pressure might have necessitated heavier turbine exhaust nozzles, hence the operating back pressure is set at 5 lb. gage.

Economizers

With this high back pressure there is expected a uniform feed-water temperature of about 220 deg. F. As will be explained later, the boilers will operate at from 175 per cent to 190 per cent rating with an expected flue gas temperature of about 520 deg. F. Although the high station load factor is favorable to the use of economizers, the high feed temperature and rather low flue gas temperatures somewhat offset the advantages of the high load factor. The installation of economizers was therefore fully studied and sufficient saving shown to justify these installations had the station not been mainly a war activity; but because the life of the station was problematical and because of the acute steel situation, it was considered inadvisable to install them at this time.

Boilers

To avoid interference with the Emergency Fleet's construction program, the straight tube type of boiler was eliminated from consideration. The boilers eventually selected were Type M, No. 55, Stirling boilers, 1508 hp., these being the largest units which could be obtained without unusual manufacturing delays. A drum pressure of 300 lb. per sq. in. was selected as the maximum available without special construction. Allowances for pressure drop through superheater and piping and for variations in working pressures set the operating pressure at the turbine throttle at 275 lb. gage. Standard superheater design indicated a steam temperature at 175 per cent rating of about 180 deg. F. superheat. Hence the steam condition at the turbine throttle was set at 275 lb. gage and 175 deg. F. superheat.

Stokers

The quality of the coal expected determined the underfeed type of stoker. The width of the boiler furnace (27 ft. 6 in.) permitted the installation of a 15-retort stoker. With a combustion rate of about 600 lb. of coal per retort, the boilers will deliver about 175 per cent of rating. This rate of combustion is such that the furnace temperature is moderate, hence no excessive clinker trouble should be expected and, further, the temperatures are not such as to cause excessive deterioration of the furnace setting. A combustion rate of 1000 lb. coal per retort, which is not excessive, will give about 275 per cent rating. The Stirling Type M boiler has a rather large draft drop through the setting

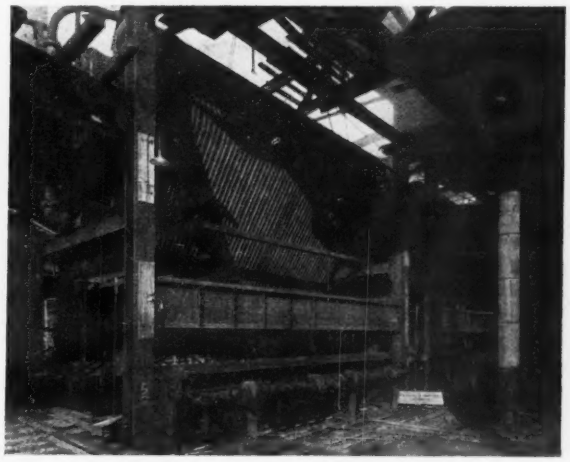


FIG. 6. 1500-HP. BOILER WITH STOKER INSTALLED BEFORE BEING BRICKED IN

at the high overloads requiring extremely high stacks or induced draft fans, hence the maximum rating of these boilers is set at 250 per cent although higher ratings may possibly be obtained.

There are installed three Kellogg radial brick chimneys, one 300 ft. by 18 ft. diameter and two 275 by 14 ft. diameter, all three 275 ft. above the boiler room floor.

Because of the uniform nature of the load the boilers will be operated at about 175 per cent rating, ten boilers at this rating being necessary to carry 60,000 kw. This ample stoker capacity will make it unnecessary to carry any banked fires because the loss of two boilers can easily be taken care of by operating the others at 218 per cent rating.

The unusually poor quality of coal obtained during the war made it advisable to install 12 instead of 10 boilers, thus giving spare capacity for repairs and clearing as well as extra grate surface. This number was increased to 15 to provide for the addition of the 30,000-kw. turbine but the order for the three additional boilers was canceled on the signing of the armistice.

Boiler Setting

Each boiler is set singly, the center of the mud drum being 7 ft. 6 in. above the firing floor giving large combustion span. The front wall of the boiler is divided into two parts, the lower being supported by the stokers, special fire tile held by bulb beam castings near the top of this section holding the wall in place. The weight of the upper section is supported by a 3-ft. steel girder and is also held in place by special tile near the top. The front and bridge walls are solid fire brick, the bridge wall being slightly concave, and the entire setting is lined with Sil-O-Cel insulating brick to keep radiation at a minimum.

In addition to the front and side stoker inspection doors, four inspection doors are installed in the bridge wall and access is given to these doors by an open room directly under the mud drum.

Boiler Control

Each boiler is equipped with two boiler meters (one for each steam outlet). Each of these meters gives a superimposed record of steam flow and gas flow. One

FIG. 7. 15-RETORT UNDERFEED STOKER LOOKING TOWARD FRONT WALL

of the meters also records the flue gas temperature and the other the speed of the stoker shaft. There is also provided for each boiler a Three-in-One draft gage and an electrical tachometer for indicating the stoker shaft speed. The instruments for the boilers of each house are located on one board at the end of the firing aisle. Each boiler panel contains the above instruments, the rheostats for operating the stoker motors and remote control for operating the forced draft and back dampers. The dampers are controlled by a special motor-operated device. The starting panels for the forced draft fans are on a board adjoining the boiler control board.

Each of the boiler houses will therefore be in direct control of one man who will be able to make a direct comparison of the operation of all the boilers in his house and the chief combustion engineer will be free to keep a watch of all fires and issue to the board operator such modifications of operation orders as change in fuel conditions demand.

Forced Draft Equipment

Each stoker is equipped with one radial flow fan of sufficient capacity for the operation of one stoker at 275 per cent boiler rating or two boilers at about 190 per cent rating. The forced draft duct is located directly under the stoker, one wall acting as a wall of the ash hopper. An auxiliary duct connecting adjoining boilers permits of operating two boilers, in case of trouble, with one fan.

The power required for normal operation is about 30 hp. but for maximum conditions, about 75 hp. is required. To have operated the fan under normal conditions with a 75-hp. motor would have been very inefficient, hence two motors were installed, one on each end of the fan shaft, one 40 hp., 865 r.p.m., and the other 75 hp., 1170 r.p.m. Up to about 190 per cent rating, the 40-hp. motor is operated at 865 r.p.m and the air pressure at the stoker controlled by the motor operated damper. Above this rating, which is only at rare intervals, the larger motor is started and operated at 1170 r.p.m. A comparison of a single variable speed motor, a constant speed 75-hp. motor and the combustion drive is illustrated by the curves (Fig. 5), showing the reasons for the selection.

Feed-Water Heaters and Purifiers

Two 15,000-hp. open feed-water heaters are installed about 15 ft. above the centrifugal feed pumps which are driven by three-stage steam turbines.

The condensate from the condensers is delivered to a dividing box to divide the return proportionally between the two heaters. A 3-in. float operated valve controls the supply of make up water. A second float operated valve, but of 6-in. size, is set to operate only when sufficient make up cannot be supplied by the first valve, for example, when the condensate cannot be returned to the heater. This avoids the usual difficulties met in trying to regulate the normal make up with the large valve necessary for emergency supply.

All make up is chemically treated to remove scale-forming matter by the softener system located on the hill. This apparatus includes an emergency storage tank of 30,000 gal. capacity for treated water and the water runs from this tank by gravity to the heater. It is proposed to run the water first to cool the transformers and thence to the heaters.

The condensate is used as sealing water in the main turbine and about 400 g.p.m. diverted through the oil cooler entering the heater at about 130 deg. F., thus reducing the exhaust steam necessary for feed heating by about 10,000 lb. per hour.

A gland water tank which is supplied from the condensate is provided with two emergency supplies so that in case of failure of the condensate the glands may not be short of water.

(To be continued)

In the operation of a bearing under normal conditions, when a continuous and unbroken film of lubricant exists it matters little what metals are used while the film is sustaining the entire load. In the starting and stopping of the journal, however, or at all such other times when the film is interrupted and metallic contact exists, it then becomes very important that the properties of a bearing metal should be present.—A. S. M. E. Sub-Committee on Bearing Metals.

FUEL CONSERVATION LETTERS

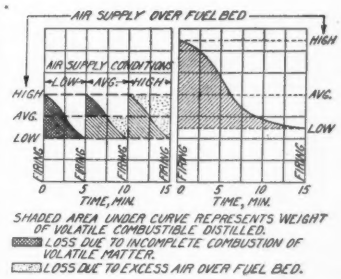
By Joseph Harrington, Formerly Administrative Engineer for the State of Illinois

Furnace Capacity. Letter No. 13

WHAT a furnace is, need not be described; but what a furnace does is frequently misunderstood. There is a definite "furnace capacity." It is represented by the amount of coal that can be burned to completion in the furnace with the least amount of excess air.

The method of stoking the coal has a tremendous effect on furnace capacity. The more gradual and uniform is the introduction of the fuel, the more can be fired without overloading.

When a shovelful of coal is thrown into a hot furnace, there is an almost instantaneous liberation of the gaseous part. When one scoop of coal is fired, the total amount of gas arising therefrom is usually not sufficient to overload the furnace. But when a number of such scoops are fired in quick succession, the total amount of gas evolved is too great to be contained within the furnace until combustion is complete, and smoke is produced. That is why all instructions for smokeless firing of hand-fired boilers contain the provision that the coal should be introduced in small quantities, at frequent intervals, rather than in large quantities at longer intervals.

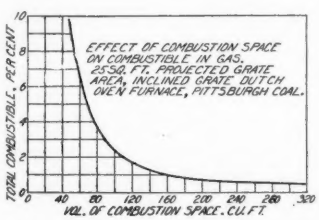

AIR SUPPLY OVER FUEL BED
AIR SUPPLY CONDITIONS
LOW
AVG.
HIGH
FIRING
TIME, MIN.
SHADED AREA UNDER CURVE REPRESENTS WEIGHT OF VOLATILE COMBUSTIBLE DISTILLED.
LOSS DUE TO INCOMPLETE COMBUSTION OF VOLATILE MATTER.
LOSS DUE TO EXCESS AIR OVER FUEL BED.

All stokers introduce coal with a greater uniformity and in smaller amounts per unit of time than the equivalent hand-firing; and for this reason, as a whole stokers will produce smokeless combustion in the same furnace where hand-firing produces a banner of black smoke.

Obviously, also, the length of flame, which is largely a function of the volatile content, affects furnace capacity. The more gaseous the fuel, the greater must be the size of the furnace.

Very seldom is the furnace sufficiently large for really efficient operation. It is a definitely demonstrated fact that the losses involved in a smoky setting are much greater than those which result from a larger combustion chamber.

Mere volume, however, is too frequently considered the whole story. Volume in itself is necessary; but that volume must be correctly proportioned or its beneficial effect is very largely lost. The time element entering into the combustion reaction is essential; and a certain amount of time must be allowed for mixing, and for the chemical reaction to be propagated throughout the mass of gas. Length of furnace or flame travel becomes necessary, therefore, in order to provide the required time. Gases pass through a furnace at a rate anywhere from 10 to 30 ft. and at least a second or two should be allowed. As the rate of combustion increases, the amount of gas goes up in direct proportion to the amount of coal burned, and the velocity of the gases necessarily increases. The furnace capacity is, therefore, quickly reached; and when reached the limit of economy is at hand.


EFFECT OF COMBUSTION SPACE ON COMBUSTIBLE IN GAS. 25.5 SQ. FT. PROJECTED GRATE AREA, INCLINED GRATE DUTCH OVEN FURNACE, PITTSBURGH COAL.
TOTAL COMBUSTIBLE, PER CENT
VOL. OF COMBUSTION SPACE. CU. FT.

Another consideration closely associated with furnace capacity is the amount of air supplied for the combustion of gases. As the amount of air is decreased, obviously more time and a better mixing effect is required in order to bring the air into proper contact with the gas. As the amount of excess air is decreased, the length of flame increases. If the reduction is carried to a sufficient extent, it is possible to prolong the flame until it emerges from the top of the stack. This phenomenon is observed in metallurgical furnaces with great frequency. Of course, the presence of a boiler between the furnace and the stack would prevent this actually being accomplished, but similar flame conditions can be produced.

In the case, therefore, of an inadequate furnace, it is frequently better from an efficiency standpoint to increase the amount of air supplied to complete the combustion within the confines of the furnace. The loss from this excess air is often less than the loss of the unburned gases due to the long flame.

Your gas analysis, therefore, should be closely watched in conjunction with the evaporation per pound of coal. With adequate coal and steam weights, your engineer can readily determine the percentage of CO_2 corresponding to his best evaporation. If this is low, serious thought should be given to increasing the furnace size, so that complete combustion may be had with less excess air.

Boilers and Auxiliaries*

THEIR CONSTRUCTION AND MAINTENANCE CONDUCIVE TO HIGH ECONOMY

THERE is a feeling on the part of operators who have had experience in this matter that the walls of boiler furnaces should be built of as few different kinds of material as possible and should be solid, well bonded and homogeneous. In fact, there is a recent tendency toward building the furnace walls of solid fire brick. Another point which may be grounded on fact is that until some more satisfactory refractory material is developed, it may be necessary to depend to a certain extent on the radiation of heat through the furnace wall to cool and preserve the furnace lining.

There has been some experimental work in progress regarding the materials used for baffles. One company reports a trial installation using transite for the rear baffle of a Stirling boiler. Another company for vertical baffling has standardized on two layers of baffle bricks with asbestos millboard in between, while still another company for a similar type of boiler has adopted the usual flame plate and baffle brick type of construction, but with one layer of brick and then 2½ in. of asbestos cement applied wet. There are several patented types of baffles on the market, a few of which seem fairly promising, but have not as yet demonstrated their practicability and durability under all classes of service. There does seem to be, however, a demand for a baffle which, compared with the usual type, is tighter, more readily renewed or repaired and can be placed at any desired angle with the tubes.

PRESERVING FURNACE SIDE AND BRIDGE WALLS

THE PRESENT-DAY DEMAND is for a furnace lining which will withstand the high furnace temperatures and blow torch action, the constant heating and cooling effect, and the abrasive action of the fuel bed. A furnace lining to which clinker formations would not adhere is much to be desired; but if this is impossible, it must have the mechanical strength to withstand the necessary barring or breaking off of the clinkers.

There are a considerable number of various and diversified means in use for preserving furnace linings.

VENTILATED WALLS

SEVERAL PATENTED APPLICATIONS of the plan for admitting air through the furnace walls in such a manner as to keep the walls below a harmful temperature, are in use. One of these patented arrangements provides ducts in the side or bridge walls connected with the forced draft system for the stoker. The air in these ducts is released into the furnace through small interstices in the usual fire brick lining of the furnace. This cooled area is applied only to the lower portions of the side walls and bridge walls, or, in general, where the action against the brick work is most severe. Another similar plan uses hollow blocks of refractory material for the furnace lining. The hollow tile form the ducts which are tied in with the forced draft system, and the air is released into the furnace through small holes cast in the hollow blocks. Schemes of this nature have been used with some success on underfeed stoker installations, and in many instances have prolonged the life of the furnace lining materially. It is said by users of these methods that the amount of air passed into the furnace for this purpose has no harmful effect on the furnace efficiency.

A refractory manufacturer has put out a fire brick the chief constituent of which is carborundum. This brick has been used to a limited extent for furnace linings and not without some success. It seems to fulfill to a marked degree the requirements of a furnace lining, but the cost is necessarily high compared with the usual run of fire brick, and its possible use is, therefore, limited.

Use of a steam jet beneath the grate to "soften" the clinkers is a very old custom and the principle is used quite extensively in connection with stoker operations at the present time. As a side wall preservative, the method used is to run a perforated ¾ or 1-in. steam pipe along the grate at the side walls and use a constant flow of live or exhaust steam. Since the principle involved is that the steam cools the flame temperature to a point below the fusion temperature of the ash so that no clinker is formed, the amount of sidewall which can be protected depends on the vertical distance to which this cooling effect can be carried, which is, of course, limited. For the more moderate conditions of furnace operation, this method is often quite effective. A necessary precaution in using this method is to see that the steam does not escape with such a velocity as to cause a blow torch action on the grate or side walls.

WATER COOLED LEDGE PLATES AND WATER BACKS

ON CERTAIN TYPES of stokers, as, for example, chain grates, the water-cooled ledge plate is used quite extensively to prevent the formation of clinkers on the sidewalls and the abrasion due to the moving fuel bed. Water-cooled cast-iron bridge wall sections are also sometimes used with varying degrees of success. A sure and positive water circulation is necessary with these devices; otherwise, they become troublesome features from an operation as well as maintenance standpoint. Air-cooled cast-iron bridge wall sections through which the air for the stoker is first passed, have been used with moderate success in a few instances. Cast-iron ledge plates have been used in connection with underfeed stokers and are reported to give fair satisfaction, if provided with fins or ribs in such a manner that a protecting layer of ash is held between the heat of the furnace and the iron.

BOILER FORCING RATES

IN RECENT LARGE CENTRAL-STATION DESIGNS, maximum boiler ratings of from 250 per cent to 400 per cent have been used in the basic calculations and carried out to a practical conclusion in the plants when put in operation. This tendency toward higher boiler ratings in modern new plants has led many operators to feel that boilers in general should be operated at much higher ratings than in the past, which in a large majority of cases was per-

* Abstract of Report of Committee on Prime Movers read before the N. E. L. A. at its 42nd convention, May 19-22, 1919.

haps a justifiable conclusion if not carried too far. During the past few years, however, there has been much disillusionment of designers and operators regarding the subject of high boiler ratings.

A boiler is often spoken of as being overloaded, when in reality it is the stoker under the boiler which is being forced beyond its proper limit. Generally speaking, the capacity which can be developed by a boiler stoker unit is limited only by the amount of coal which can be burned by the stoker equipment. Properly speaking, the capacity of the boiler is mainly a question of how high a flue temperature may be tolerated. The extremely high boiler ratings secured in a few notable boiler plants are obtained by very low ratios of heating surface to grate surface. For example, the boiler units of one, which are designed to operate at 400 per cent rating, are provided with a ratio of grate surface to heating surface of 1 to 27.3. One of the principal factors involved in high boiler ratings is, therefore, the coal burning capacity of the grate, or, in other words, stoker and furnace design.

A restraining influence on the maximum possible ratings is the fact that the boiler and stoker must be designed to operate at maximum efficiency over as wide a range as possible.

The problem of draft loss at high boiler ratings is by no means a small one and is frequently underestimated in connection with increasing the capacity of boiler plants already installed. This may be readily understood when it is considered that the draft loss through a setting increases as the square of the velocity. A boiler having a draft loss through the tubes of 0.3 in. at rating, would have theoretically, and this is borne out closely in actual test, 1.2 in. at 200 per cent rating, and 2.7 in. at 300 per cent rating. For this reason users of underfeed stokers are sometimes disappointed in capacity of these boiler installations due to the fact that the stack or fan does not provide sufficient draft to take the gases away from the furnace.

Character of boiler feed water may readily become a limiting factor in boiler ratings developed, and as a matter of fact, this is not infrequently the case. This may occur either through the water containing a troublesome amount of scale-forming ingredients, or through the presence of ingredients which cause it to prime or foam. As a general proposition, extremely high boiler ratings are desirable only in connection with plants equipped with surface condensers, and even then the small percentage of make-up water required is sometimes supplied to the system by means of evaporators. Plants using jet condensers may avail themselves of water purifying equipment, but even under the most satisfactory conditions of water purification a small amount of scale may be deposited. The salts left in the water sometimes tend to aggravate any normal priming tendency, thereby limiting the possible ratings developed.

Cleaning External Heating Surfaces

THERE HAS BEEN a broad movement toward the use of mechanical soot blowers. This movement has doubtless been aided by difficult labor conditions, which have made it almost necessary to resort to mechanical methods of soot removal. Aside from this point of view, however, there is a general feeling on the part of operators that properly selected soot blowing equipment makes a highly profitable investment, notwithstanding the fact that this apparatus is not regarded as being wholly satisfactory under severe operating conditions. Various manufacturers have been making minor improvements from time to time in their equipment and methods of installation, which for moderate boiler ratings may now be regarded as being reasonably satisfactory. Where fairly high boiler ratings are developed, some trouble is encountered in maintaining the soot blower elements located nearest the furnace, regardless of type of construction used, and care is necessary to locate these elements so that they will not be subjected to a destructive heat. Care is also necessary to see that there is no jet action of the steam against the tubes. Some trouble has developed from the use of valves which were not suited to the steam conditions in which they were used. No mechanical soot blower has yet been devised which will remove the clinker forming on the lower rows of tubes, and it is still necessary to remove this by means of a hand steam lance or by the use of scrapers.

There are a few types of mechanical soot blowers which blow jets of steam horizontally across the tubes from the side of the boiler and operate in much the same manner as a hand steam lance. These types are fairly satisfactory for boilers of width sufficiently narrow so that there is no tendency to bank the soot at the far end or to leave any soot unremoved.

Priming of Boilers

FROM THE OPERATOR'S STANDPOINT, priming of boilers is often a troublesome and sometimes a persistent and harmful malady.

It does not always happen that the fireman or water tenders know when a boiler primes, as there may be no evidence of it in the glass. In fact, the boiler room operators may be quite positive that the boilers do not prime. The real test lies in the quality of the steam leaving the boiler, or in the temperature of the steam leaving the superheater. A good method of providing a check on a boiler is to equip it with a recording thermometer on the steam outlet from the superheater. Priming will be indicated by sharp fluctuations in the superheat temperature curve. Frequently a small leak in the steam line between the superheater and main steam header offers a sufficient telltale to show whether or not the boiler is priming badly. A wet steam leak is visible, whereas a superheated steam leak is invisible.

Internal Inspection

AN INTERNAL INSPECTION of the boiler is probably the first and simplest thing which can be done. If there is oil or organic matter in the feed water, it will be evident around the water line inside of the drums. The dry pipe, if any, and, in fact, the whole steam space, should be examined carefully and any peculiarity with regard to the presence or absence of scale or mud noted.

Concentration Test

IF THE INTERNAL INSPECTION of the boiler shows priming, but without any clue as to the cause, it may be that the boiler is not being blown down sufficiently. The

following method of determining the concentration of the water in the boiler is recommended by the Babcock & Wilcox Co. and is here quoted with its permission:

A complete analysis of the water in the boilers is more or less expensive and takes considerable time. Therefore, the following method is substituted as a standard operating check which can be made periodically in a short time and which gives a close enough approximation to be satisfactory.

The method following will determine the amount of sodium chloride in the boiler water.

Obtain a pint sample of water from either the water column or the blowoff of the boiler. With a 100-c.c. pipette withdraw 100 c.c. of water to be examined by suction with the mouth. The water level should stand exactly at the scratch mark on the stem of the pipette. Deliver this sample into a 500-c.c. Erlenmeyer flask.

Then fill a 50-c.c. burette with a 10th-normal silver nitrate solution and carefully note the reading.

Add two or three drops of potassium chromate indicator.

Grasp the Erlenmeyer flask by the neck in the left hand and give it a whirling motion, at the same time run in the 10th-normal silver nitrate by opening the stop cock of the burette with the right hand. The silver nitrate should be delivered slowly drop by drop, and with the first indication of a change of color to a faint blood red tinge, the addition of the nitrate should be stopped. Sufficient silver nitrate should be added so that the body of the liquid as a whole remains a permanent red color.

Again, carefully note the reading on the burette and the difference in volume in terms of c.c. of silver nitrate used will represent the sodium chloride content of the water. To express this value in terms of grains per gallon, each c.c. of the silver nitrate is equivalent to 3.38 grains per U. S. gallon of sodium chloride.

Tenth-normal silver nitrate is of a strength equal to 16.966 grams of silver nitrate per liter of distilled water.

The above method is reliable only when the water to be tested is neutral or faintly alkaline. It is, therefore, frequently necessary to bring the water to be tested to a neutral point, or very slightly alkaline point before making the silver nitrate addition. For this purpose, methyl-orange is used as an indicator, and depending upon whether the water is alkaline or acid, an addition of either nitric acid or caustic soda is made drop by drop until the water is a faint straw color. The subsequent determination is then made as described.

The amount of concentration which is good practice is variable, and it is impossible to give any certain definite concentration and say that all boilers should be operated with a concentration just below such a point. The best method is to determine at the specific plant what concentration can be carried under the load and water conditions at that plant. Then see to it that all the boilers are maintained with a concentration below such a point.

In general, the total solids in a water will bear a certain constant ratio to the sodium chloride content, and one or two complete analyses of boiler water samples will determine such a ratio. The above check with sodium chloride can therefore be used as an approximate method of checking for total solids in the boiler.

Ordinarily, unless there is some other obvious cause for priming which can be removed, the above concentration test offers a satisfactory method of avoiding priming of boilers. It may be found, however, that the amount of blowing down required is so great as to be practically prohibitive. In such a case, it might be desirable to study the probable action of the water and steam in the boiler itself, with a view to inserting baffles in the steam drum, changing the dry pipe design, or as has been done in several instances, making a change in the point of steam offtake. It sometimes happens that a single change or addition as indicated above permits the boiler to be operated without an undue amount of blowing down.

There are various other features which should be investigated, such as source and analysis of feed water, chemicals used, purifying method of introducing the feed water into the boiler, and, in fact, any clue which looks as if it might lead to something bearing on the subject. There are some divergent opinions as to which chemical ingredients aid in priming and which do not, particularly soda ash. It is fairly generally agreed, however, that the presence of oil or organic matter, together with an excess of soda ash or magnesium salts, may bring about bad priming conditions. Surface blowoffs are sometimes used with success under certain water conditions, but as a rule these devices are troublesome to maintain and operate and the conditions requiring them can better be remedied outside of the boiler.

Superheaters

It is safe to assert that the superheater should be as carefully inspected and watched as any other portion of the boiler. It should be opened up and thoroughly washed each time the boiler is out of service for general overhauling. The handhole plates should be inspected for leaks and loose dogs. The exterior surfaces should be freed of soot or slag formation. The internal condition of the superheater may be regarded generally as being a good indicator of wrong conditions within the boiler. If the superheater shows signs of mud or scale or other foreign matter, it is time corrective means were employed to remedy these conditions within the boiler.

The question of pressure drop through superheaters is one which frequently causes operators some little concern, usually for the reason that the plant designers make an insufficient allowance for pressure drop between the boiler proper and the turbine. The operator finds himself faced with the problem of how to reduce this over all pressure loss. A superheater is necessarily designed to produce a certain amount of pressure loss at low ratings; otherwise the steam might short-circuit through the nearest tubes and permit the farthest ones to become burned. Superheaters are usually designed to operate at rated boiler capacity with from ½ to 1½ lb. pressure loss, depending on the maximum rating to be developed, and for this reason operators should be cautious about removing the cores without first obtaining the approval of the manufacturer. Since the pressure loss increases as the square of the velocity, a one pound loss at rating would mean 4 lb. loss at 200 per cent rating, and 9 lb. loss at 300 per cent rating.

The superheater as such is a very efficient piece of apparatus, but as a boiler or evaporator, it not only

becomes a source of loss through loss of superheat, but may be the cause of high maintenance as well. It may be interesting to note that at 200 lb. pressure and 100 deg. F. superheat, one per cent of moisture in the steam entering the superheater causes a loss of 17 deg. F. of superheat. This discussion brings to light the need for taking every possible precaution to insure steam as nearly dry as possible entering the superheater. Since dry pipes are used solely for this purpose, and in view of the widely varying practice regarding them, boiler manufacturers should be encouraged to make further investigation with a view to standardizing dry pipe practice, and second, operators should give the need for dry pipes careful study and consideration.

Coating Exterior Surfaces of Settings

The matter of reducing air infiltration through boiler settings by means of special preparations to be applied to the exterior surfaces of the settings has received wide attention. Various preparations are on the market and they are composed mostly of coal tar or asphaltum and asbestos. This material is applied usually with a trowel to a thickness of about ⅛ in., while the setting is warm but not hot. In order to be most effective, frequent inspections of the settings are necessary, pointing up cracks and renewing the coating where needed. For the average boiler setting, these coatings are effective, particularly if the setting is old or natural or induced draft is used to burn the fuel. Some operators find an oil plant preferable, especially where the settings are in good condition and fairly new. In plants equipped with underfeed stokers and thick solid fire brick walls, the claim is made that no setting paint at all is necessary for reasons other than appearance or lighting effect. In regard to this whole subject of preventing the infiltration of air through boiler settings, it may be well to point out that the average boiler setting contains a large number of doors and openings of various kinds, and inattention to the tightness of these or the way they are closed may cause many times the air infiltration through unprotected brick walls.

Novel Balloon Landing

ANOTHER era has been inaugurated in the aeronautic world in the wonderful performance of the first dirigible balloon built for the United States Army during the recent war—the A-4, shown in Fig. 1. This big airship, approximately 160 ft. long, of the type familiarly known as "blimp," with army civilian pilot James Shade at the wheel, has just made the trip from the Wingfoot Lake Air Station, near Akron, Ohio, to Cleveland, landing on the roof of the Statler Hotel, discharging two passengers and immediately returning to its hangar 50 miles distant. It was driven by an 8-cylinder, 90-hp. aviation motor. This is the first time in the history of aeronautics in America that any type of aircraft has been brought to a quick and convenient stop in the heart of a large city for the purpose of landing passengers.

The occasion was the meeting and dinner of the Cleveland Section of the Society of Automotive Engineers at this hotel, at which Ralph H. Upson, chief aero engineer of The Goodyear Tire & Rubber Co., and Major C. H. Maranville, commander of the Army Aircraft Detachment at Akron and Wingfoot Lake, were speakers.

Upson, who is the world's champion balloonist, having won the last great International Balloon Race at Paris, France, with R. A. D. Preston acting as aide, in a wonderful 500-mile flight, conceived the idea of making the trip in a dirigible, and with the full co-operation of the army officers of the dirigible school at Akron, who arranged all details, was able to carry out the project.

Glenn L. Martin, one of the country's noted aviators, was the first to greet and congratulate the two passengers as they stepped from the car. They landed upon

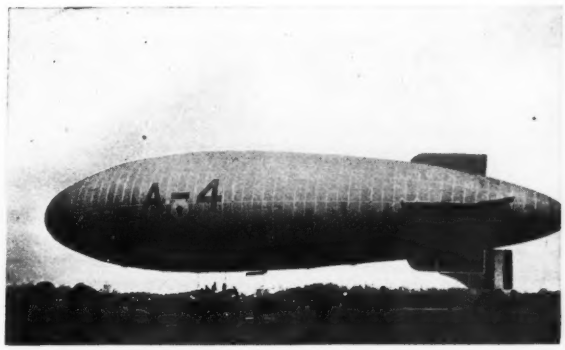


FIG. 1. U. S. ARMY BALLOON A-4.

a small improvised platform erected on the electric sign. Their landing is shown in Fig. 2.

To the thousands of interested spectators of this history-making event the conclusion was inevitable that commercial dirigible navigation is almost upon us. The performance was not staged as a "stunt," but to show the progress that has been made in the development of dirigibles and the skill with which difficult landings can be made by experienced pilots.

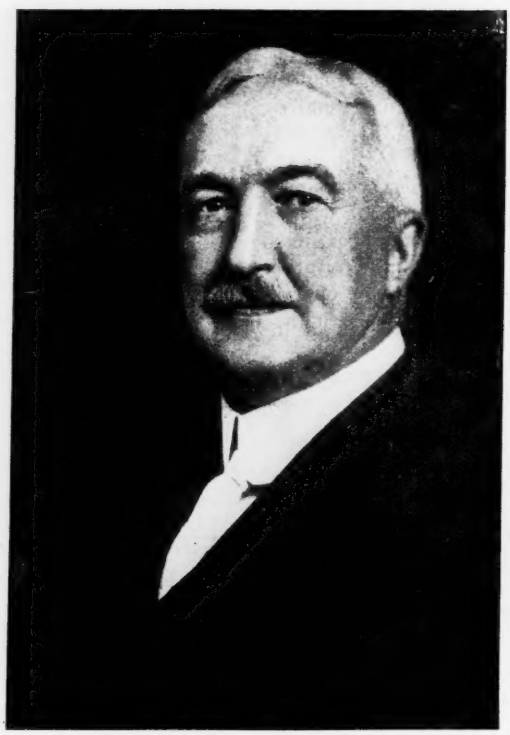
Army officers are pleased with the success of the undertaking. "We gladly entered into the spirit of the affair with the view of stimulating enlistments in the Army airship training service at Wingfoot Lake," declared Major Maranville, who was officially in command of the A-4 on this memorable trip. "The demonstration proves beyond doubt that the airship is practical and that young men who enlist in this service have a wonderful future before them. We were glad to be able to point out that the dirigible has a commercial as well as a military value."

FIG. 2. ABOUT TO LAND IN CLEVELAND

MORTIMER E. COOLEY

LEADER OF ENGINEERS, FRIEND OF YOUTH, FAIR FIGHTER AND IDOL OF THOUSANDS WHO HAVE PASSED UNDER HIS WHOLESOME INFLUENCES. BY J. R. BIBBINS

FORTY years ago, by congressional act, engineer officers of the Navy were detailed to various educational institutions for giving special instructions in steam engineering and ship building. By good fortune, one of these young officers, one standing exceptionally high in order of merit, fresh from his overseas practice cruise, and full of old-world romance and the enthusiasm of a new-world builder, was detailed to one of the middle west colleges—the University of Michigan, then an institution of broad vision, but sorely restricted in its equipment and financial resources.



It is unnecessary to recount the years of dogged, optimistic perseverance that wrought the ultimate transformation from the first meager equipment of the new department, housed in a small temporary structure, 24 by 36 ft., to the great human laboratory for technical training of today, which now commands one-fourth of the 7000 seekers after knowledge at the big Ann Arbor institution, and has placed over 3000 men in active professional life.

Today, Mortimer Cooley, seasoned executive, diplomatist, arbitrator, leader of wise men, friend of youth, good fellow, fair fighter and idol of the thousands who have passed under the wholesome influence of his commanding personality, looks back through fragrant clouds from his reflective pipe and chuckles, and dreams of still greater achievements, greater institutions of learning, laboratories of human as well as industrial research, greater success in the service of his fellows—in that deft compounding of human wisdom through intimate association with the minds of other men—so that the discordant notes sometimes sounded, now by labor, now by capital, may be merged in a greater understanding and a greater service.

As Cadet Cooley looked upon life with eager, happy eyes, so does the President of the American Society of Mechanical Engineers still look upon life; surveys the restless industrial field today, and plans and plans—that his honored profession may help to make the world safe for democratic institutions. Unconsciously, those who know him best rally to his support with heart and hand. For Mortimer Cooley never forgets a friendly deed, and demands in all justice, man to man, the same service, the same energy and the same devotion. He will not tolerate laggards in high or low places, especially among the parasitic class which seeks to bask in the light of other men's labors, particularly of young men, but with infinite patience and good-will, the instincts of the true leader of men guide him to give to his fellows freely of this store of wisdom—not only book knowledge, but of that vastly more important kind, unnamed, unmeasured, unclassified — call it diplomacy, personality, instinct, what you will.

Example: Junior college student, known as a "grind" or "crammer." Studies a day ahead of his class so as to acquire additional lustre of scholarship. Said "shark" is treading the dangerous byways of thermodynamics, and endeavors to "corner" the attention of class by asking previous questions. Without a moment's hesitation, Professor replies with serious, worried countenance, deprecatingly: "Well now, Mr. Blank, you have got me absolutely floored; but give me time and I will look it up." Wisdom of the ancients! Said shark did not tumble for two days, until the class, in the orderly course of events, suddenly passed by his "piece de resistance" and blew up his ammunition dump. He nearly died from mortification, but it was a good lesson. The Professor only winked.

Thus the name of Mortimer Cooley has become synonymous with a personality, strong, robust, virile, un-

wavering, but always kindly and helpful, magnetically cheerful and profoundly democratic, never brutal in his admonitions, tricky with his adversaries or to the slightest degree pompous in his success—in other words, the antithesis of the typical Prussian bureaucrat.

These essentially personal qualities of the individual have brought to Mortimer Cooley enviable positions of leadership, as the dean of a prominent engineering college, as the arbitrator in numerous cases of valuations of railroad and other properties aggregating more than a billion, mostly for the public but frequently also for corporations; as expert technical advisor in many court cases; deputized by the President of the United States to oversee the important student army training activities in all middle west colleges, and finally as the head of the American Society of Mechanical Engineers, in the most important period of its existence—the period of flux—when radical and conservative, "fire eater" and "stand-patter," struggle for supremacy, while the world grinds on with its wonted complexity, waiting for the engineer to assume his place as the leader of men in those walks of life for which he is peculiarly fitted. To such a task Mortimer Cooley has brought his fortunate gifts and devotion, and his selection was unanimous.

To add that he is a member of numerous societies of learning, such as the United States Naval Institute, the American Society of Naval Engineers, the American Society of Mechanical Engineers, American Association for the Advancement of Science, etc., indicates what well-seasoned timber may be found in the ranks of these learned and technical societies.

In closing this rather intimate personal sketch, some further incidents in Mortimer Cooley's training and busy professional career will serve to reveal his capacity for hard work as well as for leadership. Born on a farm in Canandaigua Township, Ontario County, New York, in 1855, he learned how to "do the chores," and he has been doing them for all human society ever since, and in true man fashion.

After Professor Cooley's detail of three years was ended the regents of the university secured a year's extension of his time; but in 1885 he was ordered to the Pacific Station for duty, whereupon the regents asked him to resign from the Navy to accept the chair of mechanical engineering at the university. This he did and his resignation was accepted Dec. 31, 1885. In the same year, the university conferred upon him the honorary degree of M.E. He became Dean of the College of Engineering in February, 1904, and of the College of Architecture in 1913. He received the degree of LL.D. from the Michigan Agricultural College in 1907, and the degree of Eng.D. from the University of Nebraska in 1911.

At the outbreak of the Spanish-American War, Professor Cooley wired the engineer-in-chief of the Navy, tendering his services. These were accepted and he served during the war as chief engineer of the Yosemite. While on blockade duty off San Juan, she engaged in a five-hour battle with the Spanish forts, gunboats and torpedo boats, as a result of having intercepted a Spanish ship which was putting in with a cargo of munitions.

During the blockade, a serious fire broke out in the coal bunkers of the Yosemite which was so deep down in the pile of coal that the crew could not reach it with water from the pumps. Chief Engineer Cooley recalled a method of sinking piles by means of a water pipe attached to the pile, which was used on the Missouri River, and applied it successfully to quench the fire. He used a slice bar along which a hose was tied, with the muzzle near the point, and, with the water discharging through the hose, the bar and hose were easily forced into the coal and the fire extinguished.

Following the war, Mr. Cooley was attached to the League Island Navy Yard for a time, first as chief engineer in charge of the machinery of a number of ships and then as assistant chief engineer of the yard. After 10 months in the service his discharge was personally handed him by the commandant of the yard with the highest commendation for his efficient work.

Professor Cooley returned to the university in 1899 and during the years following undertook a large amount of important appraisal work. In 1899 a citizens' committee, of which Governor Pingree of Michigan was chairman, appointed to appraise the Detroit street railways, asked Professor Cooley to evaluate the power plants, rolling stock, stores and supplies. This was an urgent piece of work that had to be done quickly. The appointment was made on Friday, the staff was organized on Saturday and the report made the following Saturday.

Again, in 1890, at the request of Governor Pingree and the State Tax Commissioner, Professor Cooley undertook the valuation of the state railways and with a force of 150 men completed the field work in 90 days. This covered 10,000 miles of railway valued at $200,000,000, to which in the process were added the telegraph and telephone lines, plank roads and river improvements. The investigation led the legislature to adopt the ad valorem basis of taxation. This greatly increased the amount of the taxes and the railroads brought suit to enjoin collection. In 1903-4-5 the properties were reappraised under Professor Cooley's direction at a value for the railways of $240,000,000, an increase of $40,000,000. The state finally won the suit in the U. S. Supreme Court.

In 1902 Professor Cooley assisted in the appraisal of the mechanical equipment of Newfoundland railways and in 1903 acted as consulting engineer in the Wisconsin railroad appraisal. In 1906 he was a member of the Traction Valuation Commission, Chicago, appointed to appraise all of the surface railways of Chicago, aggregating $50,000,000. In 1907 he appraised Michigan telephone properties, and has been in charge of appraisals of hydro and steam electric properties and railroads for the Michigan Railroad Commission since 1910.

The total value of the property with which he has been concerned in appraising is 1¼ to 1½ billion dollars, of which work 85 to 90 per cent has been for the public.

Thus has Mortimer Cooley established his record of unusual accomplishment and honest devotion to his democratic ideals. And he is still "doing the chores."

ONE PINT MORE water than necessary to produce a plastic concrete in a 1-4 mix reduces the strength to the same extent as if we should omit 2 to 3 lb. of cement from a one-bag batch.—Bulletin 2, Lewis Institute.

Efficiency of Liquid Fuel

Comparison with Pulverized, Hand, or Stoker Fired Coal. By Lindon W. Bates

MANY confuse the theoretical heat values of oils and coals with their practical heat or steam making values. The B.t.u. in coal, no matter whether fired by hand, by automatic stoker or pulverized, are directly inferior to the B.t.u. in liquid fuel. Herewith are cited a few references:

Navy Service

"Oil vs. Coal for Warships." In a paper recently read before the Burlington Association of Mechanical Engineers, the advantages of oil fuel over coal, for warships, were summarized as follows:

"For equal bunker weight the radius of action is increased 50 per cent and for an equal bunker space 80 per cent. Oil furnished up to 83 per cent of thermal efficiency as against 50 per cent for coal. Smoke can be controlled perfectly; when it is desirable, a dense smoke screen can be produced or the smoke can be entirely eliminated. With oil fuel, the boilers can be forced up to 50 per cent above their normal rating. Oil fuel reduced the amount of labor by about 70 per cent. There are constructional advantages in its use and ships can be bunkered at sea much more readily."

This corresponds with other Navy experiences showing a ratio of 1 to 1.66 or 1,000,000 B.t.u. to 1,666,667 solid fuel firing.

On numerous prior tests, particularly on the U. S. S. Gem in 1918 with water-tube boilers, the net efficiencies worked out the average that 1,000,000 B.t.u. in oil and colloidal liquid fuel equaled 1,333,333 B.t.u. in pulverized coal and the latter are equal to 1,666,667 B.t.u. in mine run coal.

Locomotive Service

As long ago as 1882 and 1885 on locomotives in Russia service tests were made and averaged over the years. The oil had 18,600 B.t.u. and coal 14,000 B.t.u. per lb. One pound of oil proved equal to 1.78 lb. of coal; that is, 18,600 B.t.u. in oil did the work of 24,920 B.t.u. in coal or 1,000,000 B.t.u. in oil was equal to 1,340,000 B.t.u. in coal. Oil burning improved some in 40 yr.

Another report shows the average pounds of water evaporated per pound of oil on "10 wheel," Consolidated and Mallet locomotives to be 14.38 lb. while coal gives 7 lb., a ratio of 1 to 2.054 or 18,600 B.t.u. does the work of 28,756 in coal, a ratio of 1,000,000 B.t.u. in oil equals 1,545,000 B.t.u. in coal. Another comprehensive comparison reads as follows:

"Liquid Fuel vs. Coal on Indian Railways; Results of Government Trials"

"The Indian Government has now published particulars of the trials made on the Northwestern Railway of India for burning oil fuel. Five systems were tried, viz., those known as (1) the Mexican trough, (2) the Best, (3) the Holden, (4) the Wallsend-Howden pressure, and (5) the Wallsend-Howden steam-jet systems. Of these the first and the third proved in the long run the most satisfactory. The final trials were carried out for the specific purpose of comparing selected systems with the results of coal burning. Fuel consumption was found to be as follows in terms of relative efficiency: Coal, 1; oil (Howden system), 1.79; oil (Mexican trough system), 1.85. The advantages of oil burning are given as follows: (1) Release of engines and rolling stock required for carrying coal, (2) saving cost of unloading and stacking coal, (3) locomotives cleaner and more comfortable for the staff, and easier work for the fireman, also there is a saving of one fireman per engine, as Indian locomotives as a rule carry two, (4) saving of fuel during periods locomotives are standing at stations or in yards, (5) rapidity with which steam can be raised, (6) larger blast pipes can be used to reduce back pressure in cylinders, (7) loss wastage of fuel in transit and in stock and probably considerably less stolen, (8) absence of sparks and smoke when the admission of air, steam and fuel are properly regulated. No ashes to be removed from ashpan or smokebox, no ashpits to be cleaned."

Interpreting this, one pound of coal 14,000 B.t.u. ranked with oil 18,500 B.t.u. as 1 to 1.85, thus a pound of oil with 32.14 per cent more heat units developed 85 per cent more actual caloric energy, or 18,500 B.t.u. in oil equals 25,900 B.t.u. in coal, or 1,000,000 B.t.u. oil or colloidal equals 1,400,000 B.t.u. in coal (high grade Cardiff).

In locomotive service one has the advantage of little or no firing on stops or the completion of runs, and exceptionally skilled stoking developed as a profession and by premiums.

Stationary Power Service

On return tubular boilers it was found that one b.hp. took 43,419-B.t.u. colloidal fuel Grade No. 13 with 17,200 B.t.u. and 3.45 per cent ash and 66,000 coal B.t.u. per b.hp. Here the ratio was 1,000,000 colloidal to 1,514,000 B.t.u. coal.

On B. & W. and Stirling water-tube boilers the following results are authoritative: California oil, 18,840 B.t.u. took 41,636 B.t.u. per b.hp.; California oil 18,677 B.t.u. took 41,621 B.t.u. per b.hp.

Tar Varnish for Iron Work

By Mark Meredith

HEAT about 100 gal. of tar to low boiling point, and add 100 lb. of fresh slaked lime sifted over the top and then worked down. Boil this mixture until it becomes pasty. Let it settle for a few minutes and then add 20 lb. of tallow and 5 lb. of powdered resin. Stir until thoroughly mixed and all ingredients dissolved; then allow to cool. The mixture should not be raised to a higher temperature than 100 deg. F. Should the preparation be too thick, it can be thinned down with paraffin or naphtha.

This is said to give a finish like stove enamel. At a works situated near the edge of the sea, the southeast winds eat away iron work very quickly. All gas holders and galvanized iron roofs and galvanized sides of buildings are painted two coats with this tar varnish and then whitewashed thoroughly, protecting them from the weather and salt air. The varnish is elastic and will stop corrosion.

Heat Loss Due to Scale

By F. F. Vater.

WE SEE many tables showing the heat loss due to scale on boiler heating surfaces.

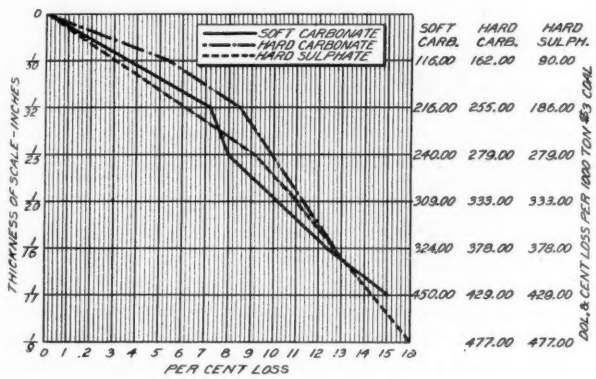
In a water softening catalog we find the following table:

1/16 in. scale means 13 per cent fuel loss.
⅛ in. scale means 22 per cent fuel loss.
¼ in. scale means 38 per cent fuel loss.
⅜ in. scale means 50 per cent fuel loss.
½ in. scale means 60 per cent fuel loss.
¾ in. scale means 91 per cent fuel loss.

This appeals to me as misleading, for the reason that no consideration is given to the kind or quality of scale, which is of major importance.

We are all members of the "show me" society who are doing great work by insisting that we know what is. In other words, guesses do not interest us.

Major (also professor) E. C. Schmidt at the University of Illinois, Urbana, has given us the results of carefully-conducted experiments to determine the heat loss due to scale.



HEAT LOSS DUE TO SCALE

These determinations were made on three different kinds of scale, viz.: soft carbonate, hard carbonate and hard sulphate. Being made with the sole object of knowing, they appeal to me. These tests were not made on scale thicknesses beyond 1/9 in. primarily, because greater thicknesses are not found in any halfway up-to-date plant.

More money is being spent in turbining scale out of tubes than will permit of ⅜ in., ½ in. or ¾ in. thicknesses being found. We are therefore more largely interested in the heat loss caused by thin scale which is not inconsiderable.

From the data furnished by Major Schmidt, we have compiled a graphic chart reproduced herein which tells a very interesting story. This chart shows that in a thin, hard carbonate scale the heat loss is greater than if the scale were a thin, hard sulphate or a thin, soft carbonate. It also shows that a soft carbonate scale up to 1/32 in. thick causes a greater heat loss than a hard sulphate scale of like thickness, but a less loss than a hard carbonate scale of equal thickness. It shows that the hard carbonate scale causes a greater heat loss than a hard sulphate or a soft carbonate scale when the scale is 1/25 in. thick or less, and that from 1/25 to 1/9 in. the heat loss is practically the same on a hard scale whether it be of carbonate or sulphate character.

We are strong believers in the dollar and cent showing in a chart of this kind because so many men look at the percentage without figuring out the ultimate loss. They are prone to think that 3 or 5 per cent is not much and let it go. It is the extensions of these small percentages that contain the surprises.

In the extension we have shown the dollar and cent loss based on $3 coal, 1000 tons burned. This showing can easily be converted to any tonnage or any price coal. For instance, if a plant burns 10,000 tons a year and pays $4 a ton, its scale is a hard carbonate 1/16 in. thick. By referring to the chart, we find the dollar and cent loss per 1000 tons, $3 coal is $378, $4 coal is 1/3 more, hence, 1000 tons of $4 coal means $504 lost and 10,000 tons $5040 lost.

Again, in a plant having a hard carbonate scale, 1/32 in. thick burning 10,000 tons a year, $4 coal, the loss is $3400. This is a sum justifying (on a 16 per cent gross basis) an expenditure of $21,250 to overcome or prevent this loss.

This chart should be of interest and use to a great many people and it is certainly more reliable than anything I have seen in print.

We all know that the scale thickness varies in any type of boiler. In the fire tube type there is more scale at the rear than at the front end; that the scale will be thicker on the tubes than on the shell; in the water tube type of boiler there will be more scale in the middle and bottom rows of tubes than in the top rows. To make the chart most valuable, the average thickness should be closely approximated.

One of the most popular divisions of education made available to disabled soldiers by the Federal Board for Vocational Education is that of engineering, in the various branches of which there are now 178 students, thus giving refutation to a somewhat prevalent idea that the vocational education available for disabled men is confined to manual trades, or necessarily must be in wage-earning occupations. In this general classification, 6 men are taking architectural engineering; 2, chemical engineering, and 80 are preparing to be civil engineers; electrical engineering takes 30; general engineering, 25; mechanical, 22; mining, 7, and steam, 8.

Indicating the character of institutions at which these men are pursuing their education, the following are being used: Harvard University, Massachusetts School of Technology, Franklin Union, Boston, Hawley School of Engineering, New Bedford Industrial School, Saunders Trade School, New York Electrical School, Mechanics Institute, Pratt Institute of Brooklyn, Rensselaer Polytechnic School, Columbia University, Heffly Institute, Lawrenceville Trade School, Carnegie Institute, Pennsylvania State College, Johns Hopkins University, Georgia School of Technology and Colorado State School of Mines.

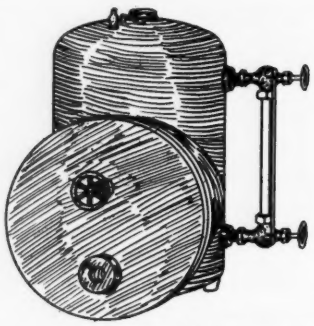
British exports of coal to South America, which in 1913 amounted to about 7,000,000 tons, fell in 1918 to about 600,000 tons.

Are Steam Traps Machinery?

If So, Why Not An A. S. M. E. Code.

By Theodore Haight

THERE ARE four kinds of steam trap users: First, the man whose traps never leak, never get out of order and never require attention; second, the man who says, "traps are a necessary evil" and "there is no such thing as a good trap"; third, the man who thinks only of price and takes a chance because it's cheap, forgetting that the cheaper they are the sooner they wear out, and besides soon having to be replaced may give no end of trouble and interfere with plant operation; fourth, the real engineer, who gets the best he can for the service intended, depends on a sure saving to pay for his first cost investment and then gives it the needed attention to bring in the dividends. In his plant you find things running like clock work, no shut-downs or smash-ups, for traps are regarded as apparatus, cared for and tested as such, instead of being considered junk.



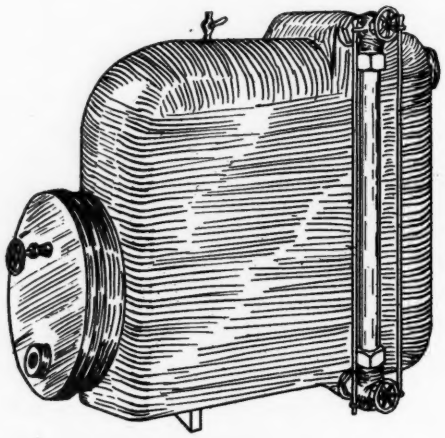


FIG. 1. AND 1A. THE OLD FAMILIAR GAGE SUBJECT TO FREQUENT BREAKAGE

Some young engineers ask why, generally speaking, traps have a bad reputation. One good reason is that traps were first used merely to prevent live steam going to the sewer or hold the pressures up on the system. Then power plant progression started; water-tube boilers were found less dangerous in case of rupture; later came superheaters and economizers; injectors were discarded for boiler-feed pumps and again reciprocating pumps gave place to centrifugals. Types and designs of engines changed; the old oil can gave way to automatic pressure oiling; even the types of packings and packing methods changed; but the old original steam traps were expected to do their work without change except additional neglect. Men have said, "I have used that kind of trap for 35 yr.; there can't be anything better, but now they give a lot of trouble because the workmanship and material is not as good as it was 20 yr. ago"; perhaps you can coax him to try something different and he gets a constant flow trap, but on account of re-evaporation from discharged condensate due to temperature at high pressures, thinks it is leaking steam or complains that traps leak water continuously and never shut off, or perhaps he buys a cheap little expansion trap and has to carry a screwdriver with which to make his daily or hourly adjustment and he gets disgusted and goes back to his old rut.

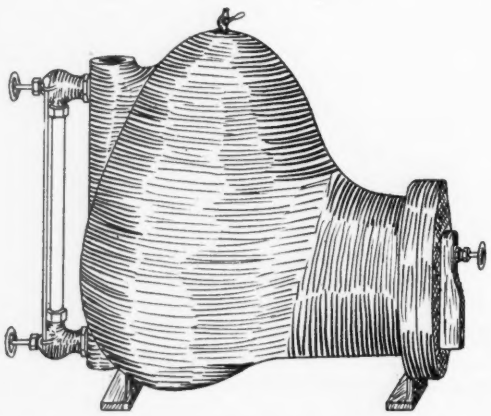


FIG. 2. TRAP WITH GAGE PLACED OUT OF HARM'S WAY

Investigation shows that there are about 243 different makes of steam traps in America, and that about eight of them would give reasonably good service over an extended period and with reasonable variations in service requirements. If this is a fact, it is time that the A. S. M. E. prepared a trap code, test requirements, capacity rating and specifications; but until that is done

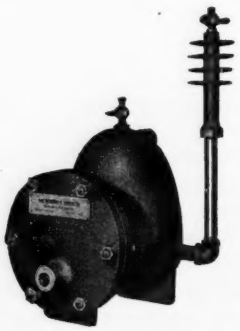


FIG. 3. THE ALL-METAL GAGE

the wise engineer will or should buy only such traps as are backed up by a proper guarantee besides carefully comparing capacity, weight and price.

I am safe in saying that in a majority of cases, there is no piece of machinery or apparatus around the plant that receives less thought and attention than the steam trap and yet the safety of every engine, steam line, in fact the whole responsibility is carried at times by that so-called "piece of junk."

Unsatisfactory operation from a steam trap can usually be traced to one or a combination of the following causes: First, type of trap not suitable for the required service; second, improper installation, piping connections or elevation; third, no regular and systematic inspection, which should include thoroughly blowing out foreign matter through provided blowoff, and if necessary opening up trap and keeping the working parts clean; fourth, installation in dark out-of-the-way or inaccessible places.

Selection of type of traps to be used aside from prejudice depends upon general service conditions.

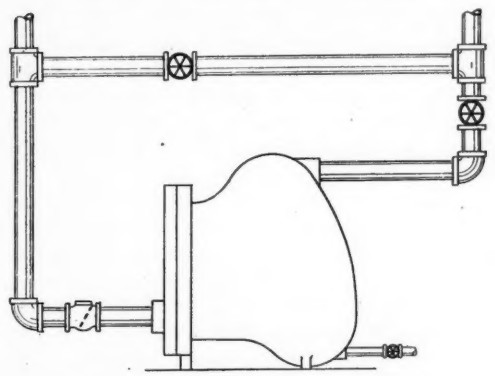


FIG. 4. TRAP WITH INDEPENDENT BYPASS

First, the working pressure under which it is to operate; second, the quantity of condensate to be handled (which preferably should flow by gravity to trap); third, will the trap discharge to atmosphere or against a head or return condensate to boiler? fourth, will the water of condensation reach trap in a steady stream or in slugs?; fifth, will the trap be required to give uniform service winter and summer, day and night, or should you calculate on overload conditions for shut-downs, weather, etc.?

Traps should have a varied discharge orifice, large for low pressures and smaller as pressures increase, and for best results orders should always be marked with the approximate service pressure on which trap is expected to be used. The following is one manufacturer's port schedule:

L. P. Special—For special service on oil and heavy liquids.

Extra low pressure—For service on pressures less than 15 lb.

Low pressure—For service on pressures 20 to 65 lb.

Standard—For service on pressures 70 to 120 lb.

High pressure—For service on pressures 125 to 165 lb.

Extra high pressure—For service on pressures 170 to 240 lb.

H. P. Special—For service on pressures 250 to 325 lb.

While the "H. P. Special" would operate on 2 lb. pressure, its capacity on lower pressures than for which it was designed would be much below the manufacturer's rating; but the low pressure traps should not, in fact, cannot be used on higher pressures for several reasons. The valve may leak, causing excessive losses; the body may be light and in danger of bursting and the volume of water discharged under high pressure may cause friction due to velocity which will prevent the trap from functioning properly, or cause the valve to slam shut with such violence as to hammer its seat and other parts to pieces in a short time, or in a rotary

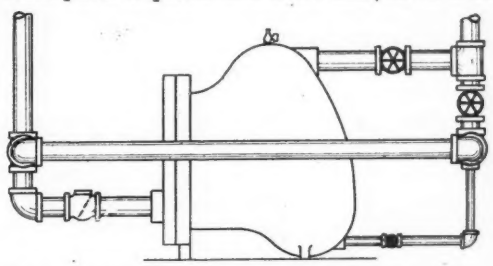


FIG. 5. ANOTHER FORM OF INDEPENDENT BYPASS

or Corliss type valve cause sticking due to friction. Here let me strongly advocate "oversizing" in bucket or tilting traps; that is, use a size or two larger than actual requirements, as the life of these traps is, to a certain extent, limited by the number of dumps or tilts and putting in the larger sized trap will so reduce the number of operations as to make it worth the additional charge.

Strainers and gages are a most important trap accessory, and I have no hesitancy in saying, will pay for themselves within a short time. As to strainers, some

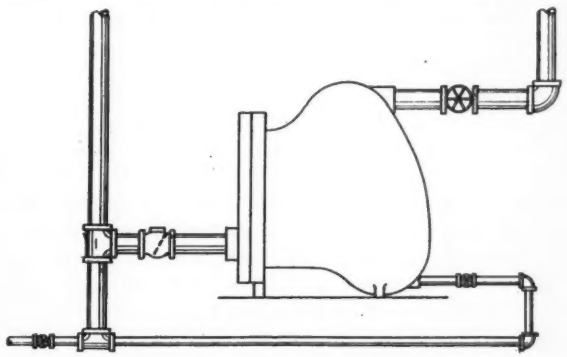


FIG. 6. BYPASS CONNECTION ALLOWING REMOVAL OF FOREIGN MATTER

are incorporated in the trap, while others are sold as a separate fitting, and I think the latter is preferable because there are some types of service where the strainer is not needed and the cost of combination trap and strainer is slightly higher; also in case of trouble it is hard in the combined unit to determine whether the fault is with trap or strainer.

The subject of gages also is an important matter.

Figures 1, 1A and 2 show the old familiar gage, but with a vast difference. In Figs. 1 and 1A you will find the breakage and repairs excessively high, and if a trap is installed in a passageway, the gage probably has been taken off to avoid accidents, for it is all too easy for a man to be laid up with a scalded ankle as a result of

stumbling or perhaps dropping a hammer or wrench against the trap. Figure 2, while the same type of gage, is out of harm's way as much as possible and besides being preferable shows a considerable saving in maintenance cost, besides which, either side of the trap can be put against a wall without having to change the gage connections. Figure 3 shows an all-metal gage with no valves to get out of order. The gage is tapped into trap below the water seal or in a bucket trap tapped through the cover with an extension nipple down into bucket; the trap is then put into operation and a pet cock on top of the radiator head opened to expel air, the pressure in the trap forcing water up into the gage; when full, the pet cock is shut off and the radiator head soon cools down to, and remains at, about hand temperature. If the trap gets water-logged, the gage will get cold; while if the trap valve leaks, the water will be syphoned out and the gage becomes steam hot, so that in the engineer's travels around his plant he can touch the gage in passing and know immediately the trap's condition.

Connections should be short and as simple as possible and an independent bypass should always be provided, as shown in Figs. 4 and 5, although I have seen a large number of cases, as in Fig. 6, where combination and bypass were working out to good advantage, and although this would not be suitable if traps were shut down for extensive repairs, yet it has the advantage of removing any collection of foreign matter and thereby removing the cause of most troubles, besides making it safe and easy to blow down traps periodically, as should be done in every plant in order to get the best operating results with minimum wear.

While on the subject of connections, I beg seriously to recommend the use of a check valve on discharge particularly where discharging against a great head or where several traps discharge into a common return line.

As long as we use steam, there must be provision for the removal of condensate and that means saparators and traps. Like separators, the trap should have slug capacity space to take care of a sudden rush of water. Make sure that your trap has a reasonable capacity for the given pipe size, the following being a fair and reasonable capacity basis, although some manufacturers would cast a large boss on a real ½-in. trap, then tap out and sell it for a 1-in.:

Pipe connection, in.	½	¾	1	1¼	1½	2	2½	3
Capacity in pounds of water per hour	1000	3000	4500	6000	9000	12000	15000	20000

Make the manufacturer of your favorite trap give the capacity in "pounds of water per hour"; you cannot judge or figure the radiating surface exactly, and nobody wants to measure up all his piping and then convert it to a 1-in. pipe basis.

At the final meeing of the Engineering Conference held in Washington, June 25, a resolution was adopted, urging institutions for engineering training to meet the growing need of combined engineering business in the industrial and commercial growth of the United States, by providing courses such that those taking commercial courses may have supplementary training in the elements of engineering and those taking engineering courses may have training in business methods and procedure.

Largest Aircraft Engine

MARKED progress is being made in the design of internal combustion engines to keep pace with the ever-increasing size of aircraft. Undoubtedly the largest aircraft engine which has been developed, to date, is the 850-hp. Duesenberg motor. It has 16 cylinders, 6 by 7½ in., in two rows of eight each set in "V" form at an angle of 45 deg. With gear drive, the weight is 1575 lb.; without gear drive, 1390 lb. On direct drive, the speed is 1500-1600 r.p.m.; and with gear drive, the engine speed is 1800; propeller 1200-1350 r.p.m. Based on the lower rating and direct drive, the weight of the engine is 1.63 lb. per hp., a remarkably low figure for an engine of this type.

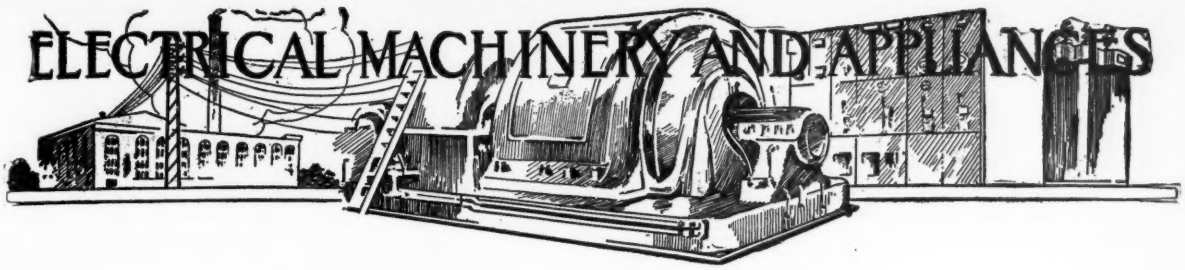
Three valves are provided on each cylinder, a 2⅝-in. inlet valve and two exhaust valves, each 2 in. in diameter. The intake valve is located above the exhaust valves, and by this plan the exhaust valves are cooled by the incoming mixture and the mixture itself is slightly warmed. Valves are operated by means of long rocker arms from a single cam shaft. This cam shaft is 13/16 in. in diameter with ¾-in. hole, and is 70⅝ in. long. The 48 cams are forged integral with the shaft. Two short exhaust pipes per cylinder of 2-in. o.d. tubing are provided, as shown in Fig. 1. Gas is provided by four carburetors, and ignition by means of two magnetos. The propeller shaft is geared to the crankshaft in the ratio of 2 to 3, running at 1200 r.p.m.

Cam shaft and rocker-arm actuating mechanism are enclosed in a dust-proof housing, and to this mechanism oil is fed under pressure. Rocker arm bearings are of special bronze, and the cam-shaft bearings are of aluminum with babbit liners. Connecting-rods are of the straight and straddle type, fitted with bearings of special bronze. Pistons are of special aluminum alloy, and each has but one ring. They are heavily ribbed inside, 5¼ in. deep and have 1½-in. piston pins.

Cylinders are made from pierced forgings of chrome-nickel steel. The cylinder head is composed of steel stampings which are first welded together, then screwed into the cylinder, and afterward welded to the cylinder. The water jacket of stamped sheet steel is welded in position. The crank-shaft is 2⅞ in. in diameter and has a main bearing between every other pair of crank-pins. Oil is forced through the shaft under heavy pressure direct to all bearings, including those of the connecting rod.

Of the barrel type, with dry sump oil pan, the crankcase is fitted with strainers at each end so that the oil will flow to the pump regardless of the angle of flight.

It has been established beyond question, says a bulletin just issued by the U. S. Training Service of the Department of Labor, that training in the industries for the industries is one of the big practical steps toward removing social unrest that is born of or aggravated by incompetence and meager wages. The publication bears the title, Industrial Training in Representative Industries, and gives a detailed account of how training departments are conducted in various plants and what results have been achieved by them. The pamphlet is for free distribution.



Power Factor Correction*

ADVANTAGES SECURED AND EQUIPMENT REQUIRED; COST OF CORRECTIVE APPARATUS

FOR any given alternating-current system, the capacity required in generators, lines, transformers, etc., vares inversely with the power factor, and the copper losses in transmission and distribution vary inversely as the square of the power factor.

With lagging power factor, generator excitation increases rapidly, and with decreasing power factors a point is soon reached where further excitation cannot be supplied without exceeding the safe temperature limit of the field winding.

Regulation also is affected by power factors and depends upon the constants of the line.

Generally speaking, the use of motors too large for the load is the most frequent cause of low power factor.

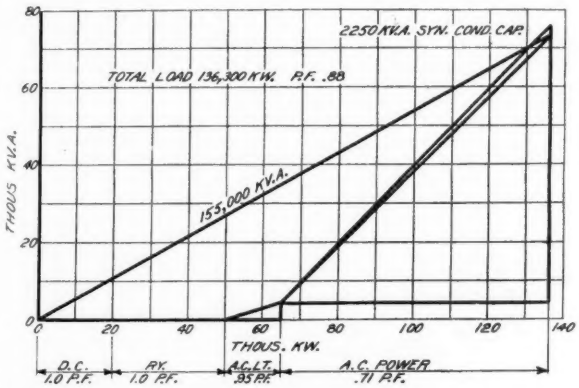


FIG. 1. EFFECT OF A LARGE UNITY POWER FACTOR LOAD IN MAINTAINING POWER FACTOR OF A STATION'S TOTAL AT A REASONABLE VALUE

Although another cause sometimes encountered is the use of motors designed for a voltage lower than the supply voltage.

POWER FACTOR SURVEY

THE BENEFITS frequently to be obtained from even a slight gain in power factor are very desirable, and it may be advisable to undertake a power factor survey of systems to determine its value at the generating plant, at the various substations, at the more heavily loaded industrial circuits and finally at the larger consumers' installations, with a view toward ascertaining whether certain remedial steps should not be considered.

* Abstract of Report of Sub-Committee on Power Factor Correction read before the N. E. L. A. at its Forty-second Convention, May 19-22, 1919.

POWER FACTOR CORRECTION AND CORRECTION APPARATUS

OFTEN considerable improvement in power factor may be obtained by rearrangement of existing motors and drives, so that the motors are loaded more nearly to capacity. Even in heavy press work, where pull out torque is a governing factor, improvement may sometimes be obtained by this method.

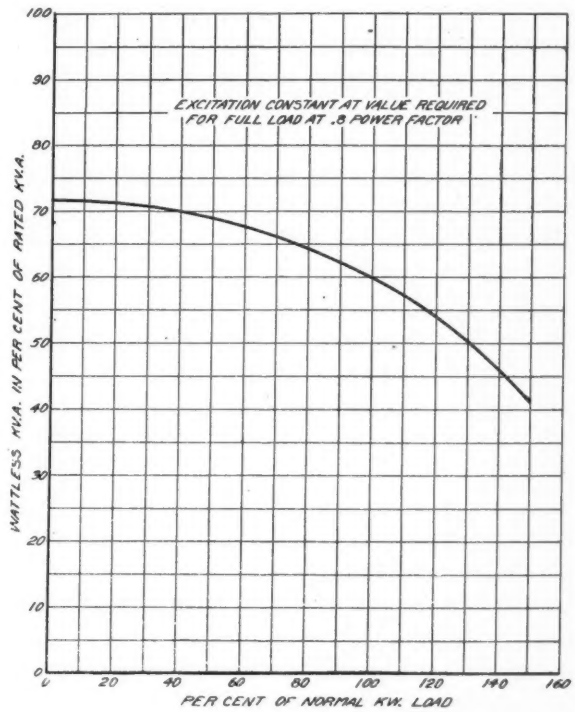

EXCITATION CONSTANT AT VALUE REQUIRED FOR FULL LOAD AT .8 POWER FACTOR
WATTLESS KV.A. IN PER CENT OF RATED KV.A.
PER CENT OF NORMAL KW. LOAD

FIG. 2. VALUE RELATION OBTAINING BETWEEN REACTIVE AND ENERGY COMPONENTS FOR SYNCHRONOUS MOTORS DESIGNED FOR 80 PER CENT LOADING POWER FACTOR OPERATION

Where additional apparatus is needed to bring the power factor up to a satisfactory value, the following may be employed:

SYNCHRONOUS MOTORS

SLOW-SPEED MOTORS of this type are suited for direct connection to compressors, refrigerating machines, and loads of similar characteristics, and have marked advan-

tages in weight and efficiency over corresponding induction motors.

High-speed synchronous motors are suited for direct

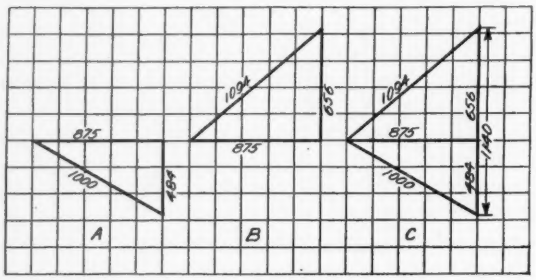


FIG 3. (A) POWER COMPONENT AND LAGGING REACTIVE COMPONENT OF INDICATING MOTOR HAVING 87.5 PER CENT POWER FACTOR AT FULL LOAD
(B) REACTIVE COMPONENT OF SYNCHRONOUS MOTOR OPERATED AT 80 PER CENT LEADING POWER FACTOR
(C) SHOWING BENEFITS RESULTING TO SYSTEM BY SUBSTITUTION OF SYNCHRONOUS FOR THE INDUCTION MOTOR

current generator drive and for general industrial drives where the load is reasonably uniform and starting and stopping requirements not severe.

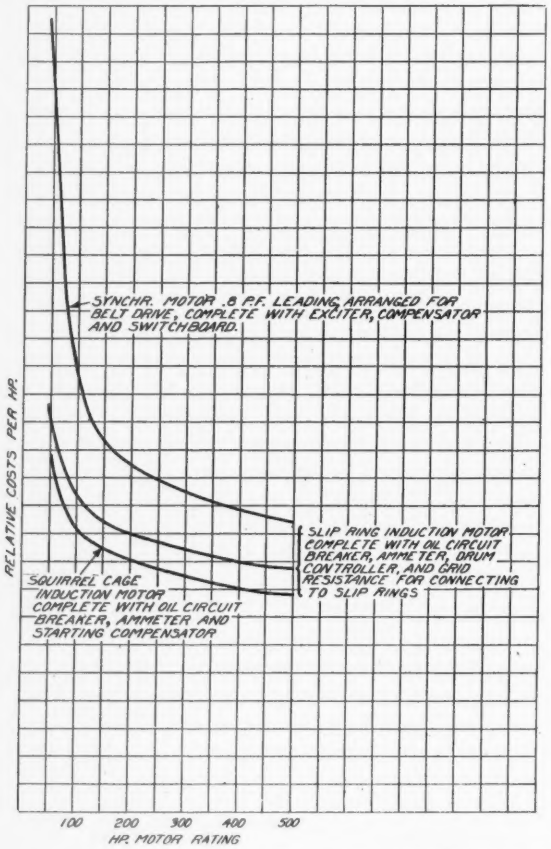

SYNCHR. MOTOR .8 P.F. LEADING, ARRANGED FOR BELT DRIVE, COMPLETE WITH EXCITER, COMPENSATOR AND SWITCHBOARD.
SLIP RING INDUCTION MOTOR COMPLETE WITH OIL CIRCUIT BREAKER, AMMETER, DRUM CONTROLLER, AND GRID RESISTANCE FOR CONNECTING TO SLIP RINGS
SQUIRREL CAGE INDUCTION MOTOR COMPLETE WITH OIL CIRCUIT BREAKER, AMMETER AND STARTING COMPENSATOR
RELATIVE COSTS PER HP.
100
200
300
400
500
HP. MOTOR RATING

FIG. 4. RELATIVE COSTS PER RATED HORSEPOWER OF SYNCHRONOUS AND INDUCTION MOTORS

In addition to doing useful mechanical work, these motors can be used to neutralize in part the active component required by inductive loads. Commercial motors of this type built for speeds under about 300 r.p.m. are usually designed for operating at unity power factor, while the high-speed motor lends itself more readily to an economical design with capacity for operating at a leading power factor, usually down to 80 per cent at full load and more at lesser loads.

Synchronous Condensers

THESE MACHINES fall in the same class as synchronous motors, but are not designed for mechanical work. Their losses are from 5 to 7 per cent of their rating and they operate at a leading power factor, neutralizing the reactive component of the inductive load to practically the full extent of their rating.

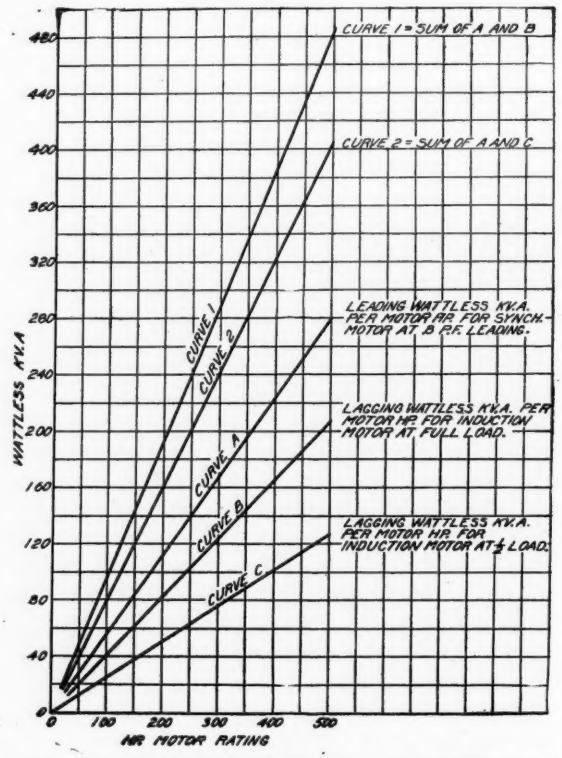


FIG. 5. APPROXIMATE WATTLESS KV.A. PER RATED HORSEPOWER OF SQUIRREL-CAGE INDUCTION MOTORS

They may also be used to maintain constant voltage at the end of a transmission line, being controlled by an automatic regulator, or they may be arranged to maintain constant the power factor of a given installation in order to meet some contract requirement.

Automatic starting and stopping control devices may now be obtained in addition to the regulator mentioned above.

Static Condensers

THIS TYPE OF APPARATUS has no moving elements and lends itself to smaller installations in which the load and power factor are reasonably constant and at which attendants are not provided. The device is highly efficient, the losses being approximately 1 or 2½ per cent.

The manufacturers have recently announced a price revision which will make the first cost of this type less

for small capacities at low voltages than the corresponding cost of synchronous condensers, while for the higher voltages the cost will be less than synchronous condensers up to some point beyond 300 kv.a.

About 3500 kv.a. of such apparatus is in use, ranging in size from 50 to 350 kv.a. units.

Primarily corrective apparatus should be located as near as possible to the origin of low power factor, but in certain cases an analysis may show the wisdom of installing corrective apparatus in substations.

Apparatus located on the premises of a consumer corrects from the point of installation back to and including the generators. When located in the substation, however, it has no corrective effect on the distribution lines or consumer's transformers.

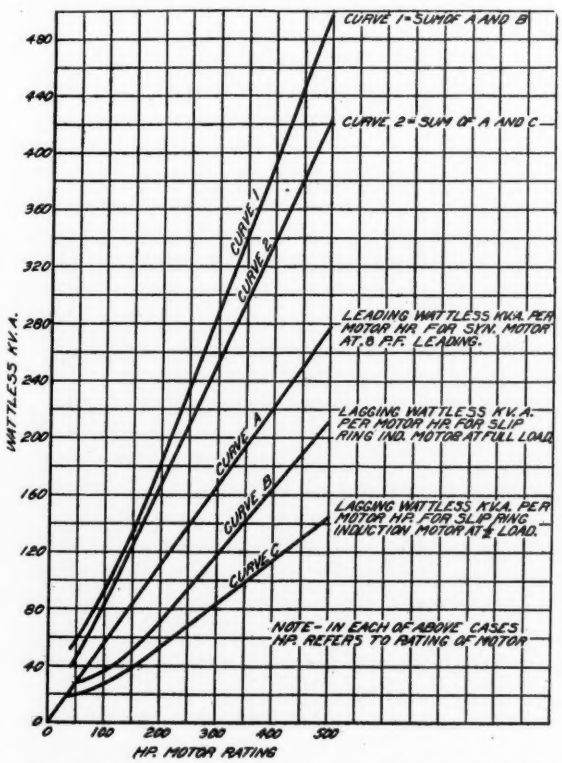


FIG. 6. APPROXIMATE WATTLESS KV.A. PER RATED HORSE-POWER OF SLIP-RING INDUCTION MOTORS

Effect of Unity Power Factor Load

The effect of a large quantity of unity power factor load in maintaining the power factor of a central station's total load at a reasonable value is shown in Fig. 1, which analyzes the component parts of such load both as to magnitude and power factor. This diagram shows the reactive component reduced by 2250 kv.a. of synchronous condenser capacity.

Relation of Reactive and Power Component in a Synchronous Motor

The problem of prescribing the size of synchronous motor to do mechanical work and at the same time raise some industrial load from one power factor to another is often encountered. In Fig. 2 is shown the relation obtaining between reactive and energy components for synchronous motors designed for 80 per cent leading power factor operation, when excited for full load output at that power factor. This curve is typical and, while individual motors will depart somewhat from this, the variation will not be great. Its use can be best explained by an example:

Assume an existing load of, say, 230 kw., the power factor of which is 75 per cent. The reactive component, which it is wanted to neutralize, then is 202 kv.a. Assume further that an additional load of 150 hp. is to be taken on and that a synchronous motor for this load is desired to bring the total load power factor up to unity.

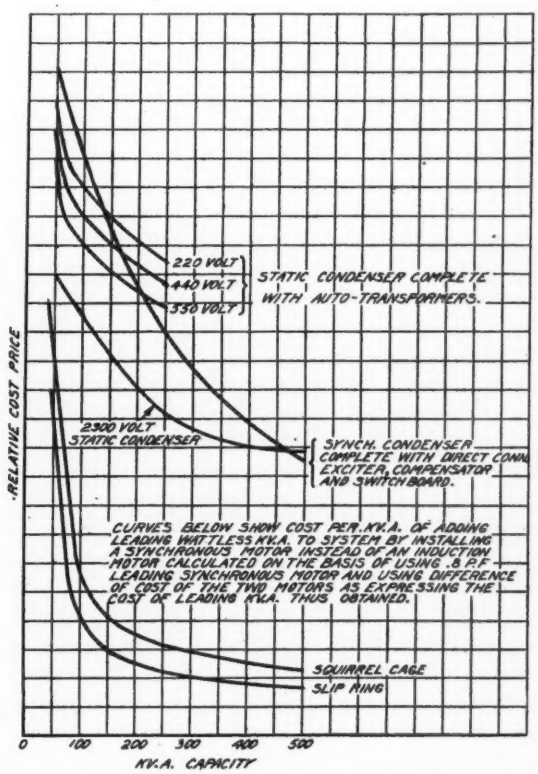

220 VOLT
440 VOLT
550 VOLT
STATIC CONDENSER COMPLETE WITH AUTO-TRANSFORMERS.
2300 VOLT STATIC CONDENSER
SYNCH. CONDENSER COMPLETE WITH DIRECT CONN. EXCITER, COMPENSATOR AND SWITCHBOARD.
CURVES BELOW SHOW COST PER KV.A. OF ADDING LEADING WATTLESS KV.A. TO SYSTEM BY INSTALLING A SYNCHRONOUS MOTOR INSTEAD OF AN INDUCTION MOTOR CALCULATED ON THE BASIS OF USING .8 P.F. LEADING SYNCHRONOUS MOTOR AND USING DIFFERENCE OF COST OF THE TWO MOTORS AS EXPRESSING THE COST OF LEADING KV.A. THUS OBTAINED.
SQUIRREL CAGE
SLIP RING
RELATIVE COST PRICE
0
100
200
300
400
500
KV.A. CAPACITY

FIG. 7. RELATIVE COSTS PER KV.A. OF POWER FACTOR CORRECTION BY THE USE OF STATIC CONDENSERS AND SYNCHRONOUS CONDENSERS; ALSO BY SUBSTITUTION OF SYNCHRONOUS FOR INDUCTION MOTORS

A reactive component of 202 kv.a. leading is required in the motor. A 150 hp. motor with an efficiency of 89 per cent has an input with 80 per cent leading power factor of 158 kv.a. and a reactive component (the corrective item) of 60 per cent as shown on the curve, or 95 kv.a. This will improve the power factor only in part and a larger motor is found to be required. If a 300 hp. motor with an efficiency of 92 per cent at half load be installed and the excitation be carried to that point which would correspond to an 80 per cent leading power factor at full load output, the input to this motor at half load will be 306 kv.a. and a reactive component of 69 per cent obtained (as shown by the curve), or 211 kv.a. A slight decrease in field excitation will reduce this component to the amount required.

Benefits Obtained by Substitution of a Synchronous Motor for an Induction Motor

Figure 3 (a) shows the power component and the lagging reactive component of an induction motor having a power factor at full load of 87.5 per cent. Figure 3 (b) shows the reactive component of a synchronous motor of the same horsepower rating operated at 80 per cent power factor leading.

Figure 3 (c) shows the benefits resulting to the system by the substitution of the synchronous for the induction motor. Here 656 leading reactive kv.a. are substituted for 484 lagging kv.a., making a total gain equivalent to 1140 leading kv.a. This assumes that the balance of the load has a power factor less than unity and the corrective effect is desired.

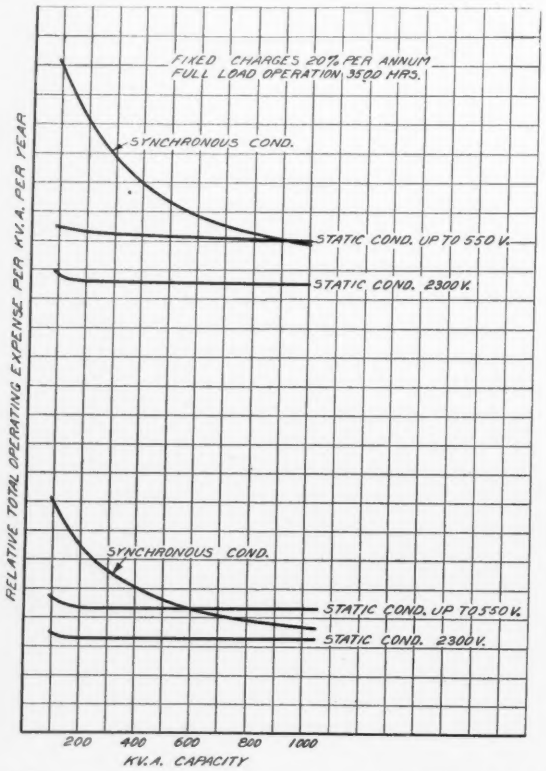


FIG. 8. COMPARATIVE OPERATING COSTS OF SYNCHRONOUS AND STATIC CONDENSERS

Relative Costs of Corrective Apparatus Per Kv.a.

Figure 4 shows the relative costs of synchronous motors and of slip-ring and squirrel-cage induction motors per horsepower rating of one large manufacturer.

Figures 5 and 6 show the equivalent gain in wattless component by the substitution of synchronous motor for induction motor of each type respectively.

Figure 7 shows the relative costs per kv.a. of correcting the power factor by use of static condensers and synchronous condensers, and also by the substitution of synchronous for induction motors. The exceedingly low cost of the latter method of correcting power factor is quite evident.

Cost curves for low-voltage static condensers have not been extended beyond 250 kv.a. This size is the largest now listed, but there is no inherent size limitation.

Comparative Operating Costs for Static and Synchronous Condensers

Figure 8 shows two sets of cost curves based on 3500 hr. during a year's operation, and including fixed charges. The upper set is based on an energy cost twice that in the lower set.

Types of Loads Suitable for Synchronous Motor Drive

Air Compressors
Ammonia Compressors
Centrifugal Pumps
Conveyors
Crushers
Fans
Frequency Changers
Grinders
Line Shafts
Metal and Rubber Rolls
Mixers
Motor Generator Sets
Pump Grinders
Reciprocating Pumps
Screw Pumps

Safety Suggestions for Electrical Workers

FOLLOWING are a few suggestions issued for the safety of the employes of the United States Navy Yard, Mare Island, California. They may well be heeded by all who have aught to do with electricity and electrical apparatus.

Shield your eyes from electric arcs or flashes. This kind of light frequently causes temporary blindness and in some cases ruins the eyesight.

Small cuts, bruises or burns should receive treatment immediately and be protected from dirt or mechanical injury. Blood poisoning may set in and must be guarded against.

Keep your eyes on your hand when reaching for electric switches. Otherwise you may touch the "juice."

Before working on electric machines lock the service line switch open and place the key in your pocket. No person can then turn on the current with fatal results to yourself. Such things have occurred.

Screw-drivers, pliers and all other hand tools should have insulated handles.

Immediately stop any abuse or misuse of electrical apparatus.

Never work on live circuits unless it is absolutely necessary. If you must work on such circuits, use all the safety devices and methods possible.

Treat all wires as "live" until you are absolutely sure they are "dead."

Unsafe or improperly working electrical apparatus should be immediately shut off and reported to the proper authority.

In working overhead be careful to place tools so they cannot fall on persons underneath.

If working on ladders or scaffolds, see that they are safe and in good condition.

Use your safety belt whenever possible. It may be your "life preserver."

Never overload a circuit or use a fuse of too great capacity. Overheating of conductors may occur, and the possibility of a fire is thus increased.

Do not leave your soldering torch burning unless you are present. Thoughtlessness in this matter on your part may cause considerable damage.

See that all combustible material is removed from places where a spark from electrical machinery or apparatus could ignite it.

Care and caution in your work are necessary for your own safety and for that of your fellow-employe.

Every electrician should know how to render first aid to a person who has been rendered unconscious from electric shock.

Resuscitation methods are not difficult to learn. If you know them, you may be able to save someone's life in a case of emergency.

Play safe. Regret for having done work carelessly or improperly will be poor consolation to you if you are injured.

Possibilities of Steam Railroad Electrification

VIRTUES OF ELECTRIC OPERATION AND ITS EFFECT UPON FUTURE RAILROAD POLICIES. BY CALVERT TOWNLEY*

ELECTRICITY fills every requirement of railroad service; but as it involves a large investment, electrification has proceeded slowly. Electrification has also been retarded because the problem has been largely considered one of replacing the steam locomotive by the electric locomotive whereas in reality the problem is much broader. It really offers a fundamentally different method of train propulsion because the limitations of the steam locomotive disappear and the strictly limited motive power is replaced by one that is practically unlimited, thereby opening up many possibilities in the methods of railroad operation. While there are a number of different systems of electric traction, all of the systems have many features in common, and the possibility of unlimited power is a characteristic of them all. A brief review is given of electrified sections of railways showing the advantages which have been realized in both the freight and passenger service. Existing electrifications have been operated for a sufficient length of time so that operating statistics are now available, and any proposed undertaking may, therefore, be predicated on established facts. While electrification will greatly increase track capacity, there is a large railroad mileage which already has more than sufficient capacity, in which case electrification would not be justified. On the other hand, there are so many cases where its advantages are clear and conclusive that when the railroads are able to finance their required electrification it will test the capacity of the electric factories of the country to serve them.

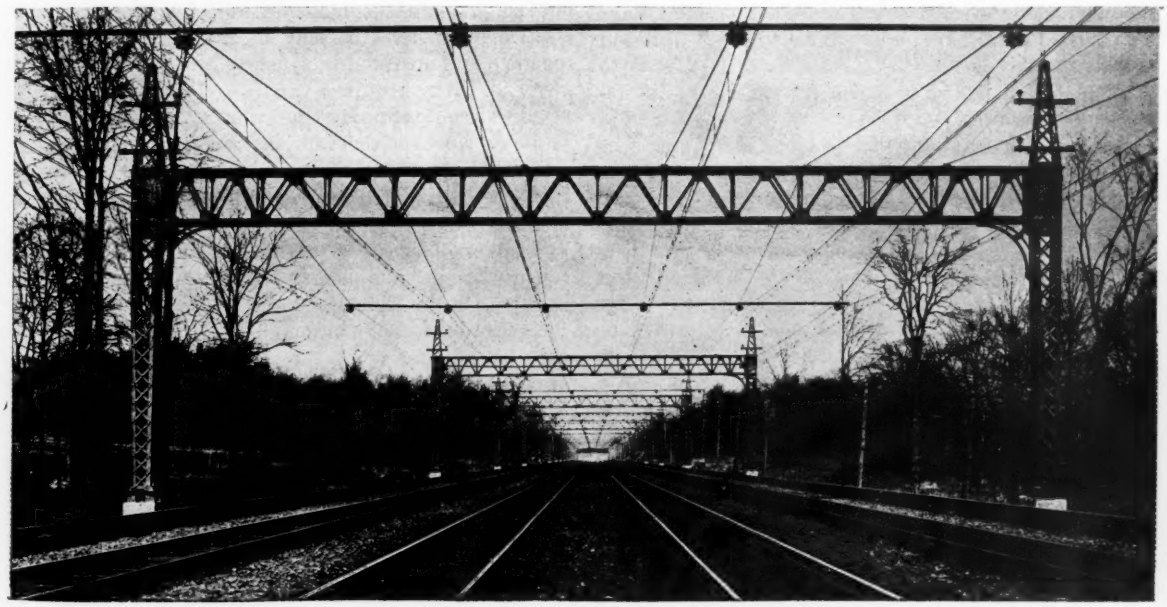


FIG. 1. SIX-TRACK TRUNK-LINE ELECTRIFICATION

Electricity now performs every railroad service previously rendered exclusively by steam locomotives, and in every case does it better than it was done before. But in order to use electricity a large investment in equipment and installation must be made, and electrification has proceeded slowly because railroad executives were not convinced that the advantages to be gained are worth the cost.

Progress of electrification has also been impeded, first, before the war, by the difficulty in financing, due to conditions other than the merits of electrification, and, second, since the war began, because everybody

*Assistant to President Westinghouse Elec. & Mfg. Co.

has been too busy to consider any work that could be deferred and because the government's taking over the railroads has created an unsettled situation not conducive to the investment of new capital for future returns. Now, however, there seems to be ground for hoping that these bars to progress will be removed in the not distant future, so that electrification can again be studied on its merits, therefore our consideration of the subject is timely.

In reviewing the past 20 years' history of this question, I cannot escape the conclusion that we electrical men, and not our steam road colleagues, are responsible for the slow progress made. We have not known enough about either the science or the art of railroading. Our belief in and our zeal for our own profession has led us, albeit with entire honesty of purpose, to make more or less extravagant claims as to what we could do and to underestimate the cost of doing it. The inevitable reaction of mind which followed an accurate determination of facts, of course, disturbed confidence in our judgment. But if at times we have injured the cause of electrification by claiming too much, strange as it may sound, we have injured it a great deal more by not claiming enough. Electrical engineers not having always been railroad men, have been unable to study railroad problems as they should have been studied; that is to say, with only real and not with any arbitrary limitations before them.

It has been natural for the electrical man to ask the railroad man for a statement of the conditions he was expected to meet. It was equally natural for the railroad man to prescribe the conditions upon which his steam service was predicated. Under these circumstances the problem became largely one of replacing one sort of locomotive with another, and of balancing hoped-for economies in operation and maintenance, on the one hand, against fixed charges for the additional investment required, on the other.

Right there comes the mistake, a perfectly natural but yet a fundamental error, for which no individual or class should be censured but for which the unusual development of the art is responsible. We cannot blame railroad men for not being electrical engineers nor electrical engineers because they are not railroad men, but the progress of electrification has to lag until both shall be able to see, each with the eyes of both. It is only by combining the railroad man's knowledge of the fundamental requirements of his service with the electrical man's skill in applying electricity to perform that service that all the possibilities of any specific problem may be developed.

Electrification of a railroad is not simply the substitution of one kind of locomotive for another. It is the adoption of a fundamentally different method of train propulsion. It is conservative to say that, within the bounds of ordinary practice, electricity can furnish every train with all the pulling power that can be used. The limitations of the steam locomotive in this respect disappear and ruling grades rule no longer. A strictly motive power is replaced by one that is practically unlimited.

There are a number of so-called "systems" of electric traction, and heavy emphasis has been laid by the advocates of each upon its points of difference from every other. So much has been said about these differences and so little about the points of similarity as to create an entirely misleading impression. It is a fact that there are more kinds and types of steam locomotives in use than there are electric systems. Except for the storage battery locomotive, which has but a limited field of application, all electric systems have more common features than differences. They agree on fundamentals and differ in detail only. Their costs may not be the same, and their efficiencies may vary, but they all do their work and do it successfully.

Possibility of unlimited electric power is a characteristic not of any one system but of all. It is due to basic differences between steam and electric equipment. A steam locomotive is a complete independent unit which not only generates but also utilizes its power. The electric locomotive generates no power at all. It is only a translating device, receiving energy from an outside and a remote source. Always having much greater capacity than any one locomotive, the electric power house can supply ample power for the heaviest train on the steepest grade. Carrying its own power house with it, the steam locomotive is limited to the capacity of its one boiler. By the multiple unit principle, as many electric locomotives as may be needed can be coupled together and operated in synchronism by one crew from any cab. Any required tractive effort can thus be exerted without slipping the wheels, without imposing undue strains on the rails or bridges and without increasing the number of engine crews.

To transport freight and passengers is the business of a railroad. I put freight first because on the average it produces 73 per cent of the revenue. Unlimited motive power permits longer trains and higher schedule speeds. On the Elkhorn grade of the Norfolk & Western the schedule speed was doubled. It cuts the operating cost by hauling more cars with the same or smaller crew. The Norfolk & Western uses two electrics to do the work of three Mallets. These new opportunities at one fell swoop banish many of the railroad's time-honored traditions. Traffic possibilities must be studied from a new angle and advantage taken of every facility. It is a new thought to realize that train length is limited not by motive power but by the yard tracks and length of sidings, or that all the trailing tonnage that the draw bars will stand can be hauled. Nor are these new limits fundamental. Sidings can be extended, draw bars can be made stronger, if it pays to do it. In a word, electrification opens up tremendous possibilities of increasing the freight capacity of a road without its being necessary to build additional tracks.

While not as important as freight, passenger traffic likewise comes in for its share in the widened horizon and the vanishing tradition. Unlimited power, of course, is available, but the absence of combustion is another basic advantage. Smoke and cinders disappear. Tunnel operation loses its terrors. Unobscured signals permit normal speeds with undiminished safety. Projects like the Pennsylvania terminal in New York, depending entirely on submarine tunnel operation and previously impracticable, become immediately possible. Railroads owning valuable realty in cities can erect buildings thereon, where before smoky locomotives made any structure above the ground level impracticable. Aerial rights

are now valuable. Multiple unit operation has, in fact, made suburban traffic. Rapid acceleration made possible by electric traction has directed attention to the equal value of rapid retardation and has quickened the study of braking accordingly; also of modified coach design to bring about the more efficient loading and discharge of passengers. These combined possibilities secure increased schedule speeds and attract patronage. Not only do people get over the line in a shorter time, but more people get over it in the same time. Again it is seen, therefore, that in passenger as in freight traffic the ability to do something that could not be done before, rather than to do the same thing at a lower cost, is the most valuable attribute of electrification, and again we find a greatly augmented capacity without the need of additional tracks.

To view the question of electrified service in its broader aspect I am going to assume the broadest possible treatment and suppose that every electrification project is to have its pros and cons most fully examined. The real and vital question, then, is, "How far will this lead us? To what extent may we expect complete electrification of all our roads?" Parts of a number of them have already been equipped. Many of these are numbered among our prominent roads, successful corporations which have had the advice of the most highly skilled executives and engineers, and which are progressive. Service performed on the electrified sections comprised virtually every kind of railroad transportation. The Bluefield division of the Norfolk & Western R. R. in West Virginia is an example of an important coal road operating through the mountains. The Chicago, Milwaukee & St. Paul 440-mile main line, through Idaho and Montana, demonstrates what can be done by transcontinental carrier on a large scale with through traffic, both freight and passenger. The New York, New Haven & Hartford R. R. 73-mile stretch between New York and New Haven shows how through freight and a heavy passenger traffic can be taken care of on the most congested four-track section of an important eastern carrier, and what is possible for complicated freight yard operation, while the New York Central and the Pennsylvania out of New York City are splendid examples of our greatest modern passenger terminal electrifications. There are, of course, many other electrifications, but even if there were not, those named are of a character to command the respect and attention of the railroad world.

Now, every one of these projects has been successful. Nearly every one in its present scope represents an extension of the zone initially electrified, the most convincing evidence possible as to what views the operating companies hold regarding these several projects. Railroad officials are generally glad to give others the benefit of their experience, so it is reasonably safe to say that operating statistics are available covering long enough periods so that the results to be expected from any proposed undertakings may be predicated on established facts and not upon theories. In the light of present-day knowledge, therefore, what answer can we make to the question, "Should all railroads be electrified?"

Taken together, in 1910 there were in the United States 240,000 miles of railroad main line, regardless of the number of tracks. Of this mileage approximately 1250, or one-half of one per cent, has been electrified or is today in process. The remaining 99½ per cent comprises, of course, roads performing every variety of service. They range from the back country branch line built by some overenthusiastic promoter and now, perhaps, operated as part of a large system only because operation cannot be avoided and regularly contributing its annual deficit, up to the most important through arteries of travel upon which the commerce and industry of the nation depend. Every sort of community is served; every kind of railroading has its place in this vast aggregation of effort, and the variables in the problem are so multitudinous and their nature often so profound as to daunt the courage of one who seeks to formulate them for incorporation in a general statement. Fortunately or unfortunately, depending on the point of view, it has been my lot to have to deal with this electrification problem from both sides. At one period from the standpoint of an intimate affiliation

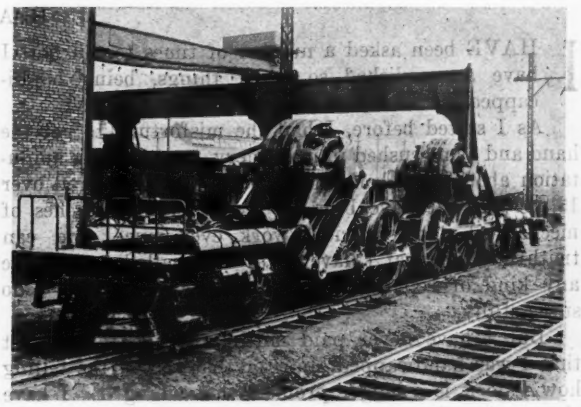


FIG. 2. ELECTRIC LOCOMOTIVE RUNNING GEAR WITH TWO 2000-HP. MOTORS

with the development and manufacture of electric apparatus and at another from that of one charged with official responsibility on the railroad's behalf.

I am a thorough believer in the virtues of electrification and an enthusiast about the wonders which it can accomplish, but I also have a keen appreciation of the most infinite variations in the railroad problem and a very wholesome respect for the dollar. I do not believe that all railroads will ever be electrified. I am not sanguine even that all the tracks of any one really big system will be so equipped in our time. It is a question of economics, and the results will not justify the expenditures even when considered with such broad vision as that which guided the Pennsylvania in spending millions to put their passenger terminal in New York City without the prospect of a direct return. Electrification will increase the track capacity. But there are thousands of miles of railroad that have sufficient capacity now, frequently several times over, and where the wildest stretch of imagination fails to picture a future need of this kind. Electrification works wonders in suburban and interurban passenger service. I have ridden for hours across the western prairies without seeing a single

town, much less a city where these advantages would count. Electrification effects marked economies in fuel, in maintenance, in labor and otherwise through a long list; but electrification calls for a heavy investment and unless these economies bulk large enough the interest on such investment will wipe them out and turn the enterprise into a losing venture. I do not believe the cause of electrification is helped by undue optimism on the part of its advocates. Rather should there be an enlightened partisanship, enthusiastic where enthusiasm is justified but tinged with the sober conservatism of the man who has to put his own dollars to work.

There need be no discouragement to the electrical engineer in the views just given, nor to the railroad man who has looked toward the new motive power for salvation. There are so many cases where electricity should be used, where its advantages are clear and conclusive, that once the railroads escape from the financial slough of despond in which they are now wallowing and are again able to get capital for their needs, there will not be enough engineers, there will not be enough electric factories in the country to serve them. Every big system has need of electricity somewhere. For some small roads it may mean the difference between solvency and bankruptcy. I electrified a short derelict line for the New Haven Road, between Meriden and Middletown, long before given over into the one-train-a-day-annual-deficit class and turned it into a good earner.

There can be no rule established. Generalities are sure to be misleading, but electrification is now firmly intrenched and successful. It is recognized by railroads generally as an effective agency with great possibilities and one which is particularly valuable for certain specific purposes. Time alone will tell how broad its application is to be, but I am confident we can await developments with tranquility, assured that the art is in a healthy condition and that progress will be along the right lines.

One-Handed Methods

By H. A. Cranford

I HAVE been asked a number of times to tell how I have accomplished so many things, being handicapped, as I am, in having the left hand off.

As I stated before, I had the misfortune to get the hand and arm crushed in machinery, necessitating amputation about 4 in. below the elbow. This occurred over 13 yr. ago. I have been in the different branches of mechanical and electrical work ever since, and can truthfully say that I have never been called on to make any kind of repair or installation that I couldn't do successfully.

But I have never paid much attention to the fact that I was handicapped, and for that reason the telling how I do it is a bigger problem than doing it. I have always found that the biggest proposition connected with doing any kind of work is the WILL to do it, and when you get right down to hard tacks and make up your mind to do a certain thing and then start at it, the job is about two-thirds done.

Before trying to tell how certain work is actually done with one hand, I want to call the reader's attention to several different things that help a person who is maimed, but still wants to follow industrial work.

It is a known fact that when a human being loses any part of his body, some other part of the body will receive an additional supply of nourishment, and in time becomes more proficient. This is clearly proven by the fact that after a person suffers the loss of either arm or leg, and has recovered, his weight will approximate what it was before the amputation.

It is also a fact that a cripple becomes mentally stronger or, rather, more proficient, because there are fewer muscles, etc., for the mind to direct, and the additional exercises that the remaining muscles get tends toward higher development so that the person becomes stronger both mentally and physically.

Another thing: If the person who marvels at the many feats that have been performed by cripples will stop and think how very few things that he does for which he actually uses more than one hand, he will be surprised; then think of how many things he uses two hands for that he could really do with one hand; then remember the time that he was trying to pack the piston of a small boiler feed pump and the space was so small that he burned both hands trying to get them in where he was really wanting to put the packing, and after actually putting in the packing with one hand, it may have occurred to him that if he had had only one hand he would have valued it too much to be careless enough to burn it. A man once refused me a position because he was afraid that with only one hand to work with I might get caught and get hurt. Mr. Employer, you need not use this against a cripple. I have heard of a good many men losing one hand, but never heard of them losing another one afterwards.

The first piece of money that I earned after my accident was for climbing a 40-ft. pole with climbers. I learned to climb with climbers several years before. One day, after my arm had healed, I was watching a crew getting ready to raise a smokestack. They had placed a pole with block and tackle rigged on it. When they were ready to start raising the stack it was found that the blocks would have to be changed before the rope would run free. There was a pair of climbers in the village and somebody brought them and several different ones put them on, tried a step or so up the pole, then backed down.

I asked them what they would pay me to do it. They laughed at me and it made me mad. I slapped on the climbers and started for the pole. Several friends tried to dissuade me, on account of having just one hand. I told them all the climbers that I ever knew climbed with their feet, or at least that's where I always noticed the climbers buckled on, and that I was going to climb that pole. I did. I had climbed poles 70 ft. high, but before I got to the top I decided that that pole was the tallest that I had ever been on. But I made it all right, was about out of breath when I managed to get down, and was as sore as rip the next day, but my confidence in myself was strengthened about

100 per cent and I had $5 more in my pocket. A lineman does not use his hands in climbing, but merely to keep his body the proper distance from the pole, and to guide himself.

I have climbed a good many poles since that day, and none of them ever gave me any trouble. The next work that I did was house wiring. It was hard work at first and I realized that I would have to work very fast if I was to compete with my more fortunate brothers. I used a small Yankee drill to start screws. As a result, my work looked nicer than that of the fellow that drove the screws with a hammer, and I did not break porcelain, while he murdered a lot of it. I used the crippled arm to stretch the wire. The brace and bit was not a particle of trouble, as I could press it against myself with my arm. A person seldom actually uses all the fingers on both hands at the same time. He uses the fingers on one hand and the strength of the other arm. Naturally, I had to learn to balance myself on a step ladder better than a man with both hands, although, if a step ladder tilts or falls with a man, there is generally nothing to catch to, if a man had as many hands as a caterpillar has crawlers. In house wiring I soon found by observation that most of the men's time was spent placing ladders, moving from place to place, etc., and a lot of time was lost. I found out that if I moved faster when not actually using the tools I could make up enough time to spend a little more time on the work than the others spent, and still turn out as much, and a lot of times better, work as the others. I practiced this, and people would often say they could not see how I got along so fast. I didn't move quicker than they did, but I moved faster all the time than they did. This trained me to work faster and faster and it has been worth a great amount to me.

My next work was house painting. I followed this when a boy and there was no other work, so I prevailed on a friend to let me paint a house. This was very simple work, for I had never seen a painter with a paint brush in both hands. It was easy to balance on the ladder by standing on one foot with one leg thrown over a higher round, similar to the way in which a lineman stands on a cross-arm.

It was not possible for me to reach as far as a painter who had both hands could reach, but I soon observed that he never reached as far as he could, and that by turning on the ladder a small amount I would cover about as much space as he would without moving the ladder. When he would come down to move, he would take time to take weather observations and comment on sundry topics before going up again, and I would move and get back with more than enough time saved to compensate for shorter reach. When the work was measured and it was found I had as many squares as the others, they would always exclaim, "Well I don't see how you do it."

Next came paper hanging. The first ceiling paper that I attempted to put up was at home and came very near causing trouble between friend wife and yours truly. Wife was to assist me. We got everything ready and a sheet of paper pasted and folded, and she was to hold one end of it while I matched it and then brushed it on. We made the start all right and in less time than it takes to tell it, I was wrapped up in the stickiest mess of wall paper you ever saw. I was mad. As per human nature, or rather I should say, male human nature, I proceeded to blame the madam with the failure. As her eyes were full of paste at that particular moment, she wasn't in a very loving mood. She is considerably larger than I am, and it was with a right smart of relief that I viewed her form going out of the door, without having opened hostilities.

I called on one of my boys and tried another sheet. This was a worse failure than the first. I chased him away and sat down thoroughly discouraged. In about a half hour I decided to hang that room of paper or ruin every foot of paper trying. The next sheet went up fairly. I held the sheet against the ceiling with the end of the crippled arm, until I matched two figures with the good hand. I then pressed the paper with the crippled arm where I had matched it, until with the good hand I matched another figure. I started brushing the paper from this point, letting it unfold as I brushed. It was tiresome straining work, but the room was finished that day. The next time it was less trouble, and speed soon came.

This covers about three years. Since that time I have been connected with power plants and garages in all the different departments. In another article I will try to take up the different repairs that I have been called on to make from time to time. I wish, however, to impress the fact that if the mental faculties are kept keyed up, the solution to a problem will always present itself as the work progresses. The main thing is to make up your mind to do a thing somehow, and then get at it. I have often been called on to do work that I couldn't see for the life of me how I was to do, but a way presented itself as fast as I made the effort to do it. It's confidence in yourself that counts. Make up your minds that the physical man or the body is nothing but a fine piece of mechanism, and that it must operate as you will that it should operate. Make the muscles the servants of your mind.

EVIDENCE that the disabled men taking vocational training under the supervision of the Federal Board for Vocational Education accumulates daily in the offices of the Board. The Dean of a far western college, for example, writes in praising the industry and application of one of the Board's students placed for training in his institution and adds, "If you have any more like him, send them along." This boy had a spinal injury that paralyzed both legs. His disability is rated at 100 per cent; but he will, nevertheless, soon be ready to fill efficiently a position as accountant. The Federal Board has thousands more like him.

Another case is that of a western boy who lost an eye in the service. He has taken an eight weeks' course in tractors and gas engines, and has been placed in a shop for supplementary training. After a few weeks the manager of the plant said to him, "Boy, I like the way you are taking hold here. You will get a $40 bonus check for this month."

Any disabled soldier interested to learn what Uncle Sam will do for him should write to the branch office of the Federal Board for Vocational Education in his district, or to the Federal Board for Vocational Education at 200 New Jersey Ave., Washington.

Deterioration of Ice Plants

Repair Defects to Prevent Loss, Increasing Life of Equipment. An Experience in Replacement. By Fred Ophuls*

EXPERIENCE of 7 yr. shows a lack of understanding between the management and the operating force as to wise policy in making repairs and improvements. Each department is anxious to make a success of the business, but co-operation is possible only when the two departments understand each other's viewpoints.

In most cases, inefficiency is due to desire to save on upkeep expense, which misleads the judgment as to what repairs the management should allow to the operating department. And in many cases the operating department lacks the moral courage to ask for repairs and improvements that are absolutely necessary. This lack of understanding is often the reason for neglecting repairs, which sometimes results in discarding machinery which should have been maintained.

There is a link missing in the chain by which sound business is supported, if the engineer has not sufficient knowledge of engineering and financial matters to sit down and analyze the equipment and cost of operation of the plant so that the result expressed in dollars and cents can be laid before the management, with recommendations as to remedying wrong conditions, which the management will have no difficulty in understanding.

Then the consulting engineer, or the chief engineer of a company that operates a large number of plants should step in, with an impartial viewpoint and make recommendations.

Always Repair Defects

There is one main rule which every user of machinery of any kind should adopt and carry through without fail. That rule is: Make repairs of any defect, no matter what it is, as soon as the defect is discovered. There is nothing which will increase deterioration of apparatus and machinery so much as to keep it in service after it has shown defects. This is as true of an apparatus which has no moving parts, such as condensers, etc., as it is of moving machinery, such as compressors and engines. Any defect which may develop during operation, if it is not repaired immediately, will increase and often lead to very serious accidents besides resulting in increased cost for repairs and renewals.

This manner of operating will cost more than a timely shut down will reduce the earnings due to the reduction in output. It is up to the management to discourage the operation of defective machinery and apparatus. I might even go so far as to say that it should not permit it. The operating department must, on its part, arrange such repair work so that the actual shutdown of the plant for repairs will be as short as possible. Unfortunately it has not been customary in ice making plants to furnish duplicate units. The reasons for this are many. One of the most important is that men with a limited capital often start ice making plants and naturally on account of limited means available can purchase only the most necessary apparatus. However, it is excellent policy as soon as the business is successful to lay aside and spend at the proper time a certain amount of money for the duplication of parts.

Continuous Operation Not Best

You know that it is customary to operate ice making machines six months at a time without any shutdown and I have heard operating engineers boast of the fact that a certain machine was started in May and never shut down until October. While I never commented on this statement before, I wish to say here that it is not very creditable to the operating engineer to have operated the machine continuously for that length of time, nor is it in the interest of his employer. There is no machine made which will stand such abuse without undue depreciation. A machine that has been operated that length of time without a shutdown must develop clearances in the various bearings and interconnecting links which are dangerous to the life of the machine and may, after a number of years, cause a complete wreck with the consequent loss of property and possibly of life.

Getting Out of Date

Another form of depreciation that deserves consideration is 100 per cent depreciation or obsolescence. The management of ice plants sooner or later is confronted with a very serious problem, the proper solution of which means life or death to the enterprise. There is, fortunately or unfortunately, depending on which way you look at it, constant progress in the development of all classes of machinery and systems. In the last 10 yr. or more various improvements have been made not only in the ice making systems as such, but also in the refrigerating equipment. Just as an example I might mention the raw water ice-making system, high-speed ammonia compressor, return liquid feed systems of the gravity or positive type, electrically driven plants, vertical, straight tube shell type ammonia condensers, compound ammonia compression with its ramifications and others of more or less importance.

This progress in the art may lead to obsolescence, or 100 per cent depreciation of some or all of the equipment. I say "may lead" advisedly. If it were not for this word "may" there would be no problem.

Unfortunately the problem is not so easy to solve unless the management can get from its operating department a fairly accurate statement of the apparatus and machinery required to make the improvement and in sufficient detail to obtain intelligent prices for them; the new operating expenses and the positive assurance that all the local conditions such as quantity, quality and the temperature of the water, etc., are favorable or at least not more adverse than they were for the old plant. The management must then complete the analysis by determining the cost of the new equipment, the saving in operation expenses resulting from the

* From a paper before the Pennsylvania Ice Mfrs. Assn.

change, the increase in the fixed charges and compare this data with the records of the old plant and to the book value of the machinery, materials and apparatus that it is intended to discard.

In this connection a word of caution is not misplaced. In figuring the cost of the new installation and the new operating expenses figure liberally, that is, conservatively. In making an estimate of the cost of an addition to a plant or of a new plant add for contingencies not less than 15 per cent to the summary of the prices received. These contingencies will crop up in spite of your most careful work. The same must be said of the comparison of operating expenses. You must remember that in the life of the management and the operating department such serious questions do not come up often enough to make them expert in this work, nor are those that seek to advise them in these matters always absolutely disinterested in the results of the figures.

When to Scrap Old Plant

Several cases have come to my attention where the installation of what was claimed to be the most modern equipment resulted in increased operating costs and fixed charges over those of the discarded equipments. This fact is to be regretted, for although the existing ice plants are the test shops for all improvements devised in this class of machinery, the management of these plants should not permit itself to be carried away by mere figures unless these figures are such as to allow for certain inevitable slip-ups. My opinion is that a proposition of this kind is sound only when the figured saving in operating expenses plus all fixed charges is sufficient to eliminate the book value of the machinery equipment discarded, less the amount that can be realized from the sale of the latter in 4 or 5 yr.

As an example of the point, I might mention one such case in which I was interested. It was decided to discard two steam driven refrigerating equipments and install an electrically driven plant at a third steam driven refrigerating plant. The new plant was to be of ample refrigeration capacity to take care of the load of the two plants discarded and in addition have some reserve capacity for future increase. Not having the exact figures in mind, I shall give approximate figures only.

Estimated cost of the new equipment was about $140,000. The actual cost about $160,000. The book value of the plants discarded was about $250,000. The calculated saving in operating expenses deducting for depreciation, interest on new investment, taxes and insurance was around $35,000 per year, figuring coal at the pre-war figure of $3.50 per ton. The actual saving, not taking into consideration the great increase in the price of coal, was $50,000 for 10 months' operation last year. In addition to this we realized not less than $45,000 on the sale of the discarded machinery for which we allowed only $15,000. The excess of $30,000 realized on the machinery sold more than took care of the additional cost of the new plant. The higher cost of the new plant was occasioned by war conditions, yet the same conditions greatly enhanced the value of the machinery discarded. In this case the book value of the plants discarded will be eliminated in less than 5 yr.

General Depreciation

Looking at the physical aspect of the subject of depreciation, it can be broadly stated that there is not a piece of apparatus used in an ice making plant that is not subject to wear. Taking, for instance, the boiler of the steam driven plant. It is fair to say the life of a boiler can be increased 100 per cent by paying proper attention to the conditions under which it has to operate and by keeping the boiler always in the very best of condition. There are some boiler feed waters which will pit the tubes and such waters must be treated outside of the boiler so as to remove this objectionable quantity. Some waters cause the formation of scale of various hardness and the accumulation of scale on or in the boiler tubes will not only decrease the efficiency but cause rapid deterioration of the tubes if the scale is not removed often enough so that its thickness never exceeds 1/32 or at the most 1/16 in.

On the other hand, the depreciation of the freezing tank equipment can be reduced by using calcium-chloride brine. By this I mean calcium-chloride brine which does not contain appreciable amounts of magnesium-chloride. A good grade of calcium-chloride will not attack either the ice can or brine cooling coils or the freezing tank. The only disagreeable feature of the calcium-chloride brine is that it wears out the shoes of those operating on the tanks unless special precautions are taken. I think it would pay every ice plant owner to furnish his employes with rubber-sole or wooden-sole shoes when operating on freezing tanks in which calcium-chloride is used.

Every point is in favor of calcium-chloride. There is only one precaution to take and that is to be sure that the calcium-chloride does not contain considerable amounts of magnesium-chloride, because the presence of magnesium-chloride in the brine together with galvanized iron cans and black iron pipe coils will produce electrolytic action and consequently rapid deterioration of the cans and coils. However, this deterioration will in no case be as rapid as that caused by common salt brine.

Paint on Ice Cans

I find that ice plant owners paint their ice cans. While this may preserve the cans to a certain extent and make them last several years longer, this painting should never be done, because no matter what kind of paint is used it insulates the cans and if the fuel or power used is in any way increased by painting the cans, it would be much better to let them deteriorate and purchase new cans when necessary. This, of course, does not apply to the seams of the cans which may be painted and it may be that such painting will increase the life of the can to a certain extent.

Taking, for example, also open air ammonia condensers, in a good many plants it is customary to scrape and paint open air ammonia condensers every season. I have found that generally paint does not stay on pipes over which water constantly flows. If the paint is of such quality that it will stay on the pipe, then it also insulates the pipe and it defeats the object for which the condenser was installed and furthermore causes loss in efficiency which oftentimes becomes seri-

ous. Those parts of the condenser over which water is constantly flowing should not be painted; they should be kept as clean as possible and as free of scale as possible at all times. However, such parts of the condenser as return bends and the ends of the pipe threads which may protrude from the return bends, the headers and valves and connections likely to be wetted by the splashing of the water should be painted regularly and whenever they show any sign of rust should be scraped and painted immediately.

It is not in the province of my talk to mention each separate part of an ice plant and show how one must proceed to obtain longest possible life, that is, low depreciation, with lowest operating expenses, including upkeep charges. These few examples are given only to show how important it is to have through personal knowledge or some other source the experience gained by others. Those who lay value on their own experience only or can learn only from their own experience have a hard road to travel and it is a road which does not always lead to success.

The Proposed Department of Public Works

FAR reaching changes in the executive machinery of the Federal Government were proposed in bills introduced in each house of Congress June 25. The Federal Department of the Interior will become the Department of Public Works, if the legislation proposed is enacted. The main idea is to assemble all engineering activities of the Government in one department.

Such bureaus of the Interior Department as are non-engineering in character are to be placed under the jurisdiction of appropriate departments, while engineering bureaus from other departments are to be included in the Department of Public Works. The bill proposes that the Patent Office is to be removed from the Interior Department and placed under the Department of Commerce. The Bureau of Pensions is assigned to the Department of the Treasury. The Bureau of Education goes to the Labor Department. The Bureau of Indian Affairs also is transferred to the Department of Labor, with the proviso that the engineering and construction work and the land and mineral surveys now performed under the direction of the Bureau of Indian Affairs are to be prosecuted under the Department of Public Works. St. Elizabeth's Hospital and the Freedman's Hospital in this city are assigned to the Treasury Department. Columbia Institution for the Deaf and the Howard University go to the Bureau of Education, under the provisions of the bill.

On the other hand, the Department of Public Works is slated to absorb the Supervising Architect's Office of the Treasury Department; the Construction Division, River and Harbor Improvements, Mississippi River Commission, and California Debris Commission of the War Department; the Bureau of Standards and the Coast and Geodetic Survey of the Department of Commerce; the Bureau of Public Roads and the Forest Service of the Department of Agriculture.

The bill provides that the Secretary of Public Works "shall by training and experience be qualified to administer the affairs of the Department and to evaluate the technical principles and operations involved in the work thereof." The measure excepts from the foregoing provision the Cabinet officer who is at the head of the Department at the time of the passage of the bill.

Four assistant secretaries, each to be paid $7500 per annum, are provided and their duties outlined. One assistant secretary is to have administrative jurisdiction over all matters of engineering design and construction. Another is to have charge of architectural design and construction. The third is to have jurisdiction over all scientific work and surveys, while the fourth assistant secretary is to be in immediate charge of all land and legal matters. The assistant secretaries are charged with the duty of coordinating and bringing into efficient relationship all the activities of the department so that it may be harmoniously and efficiently administered.

An important feature of the bill is the proviso: that engineer officers of the U. S. Army detailed on non-military work are to be assigned by the Secretary of War to like duties under the new department, for not over two years. This enables the Secretary of Public Works to make gradual transfer of improvements and instrumentalities to civil administration without detriment to public interest. Members of the Corps of Engineers may, under the direction of the Secretary of Public Works, be detailed by the Secretary of War to temporary duty in the new department for such instruction, training and experience as is desired.

The bill was introduced in the upper house by Senator Wesley L. Jones, of Washington, and in the lower house by Representative Frank C. Reavis, of Nebraska.

Trucks for Transportation Shortage

IN THE next few months, this country will suffer from inadequate transportation facilities fully as badly as it did at any time during the war," says R. E. Fulton, vice president of the International Motor Co. "Discerning business men see what is ahead of them and are preparing now. Those who fail to do so will suffer serious loss later.

"The best authorities in the country agree that, beginning with the conclusion of peace, this country will enter upon a great era of business activity and prosperity. With such a situation before us, the railroads should be increasing their facilities to handle the extra volume of freight; but just the opposite is the case. Because the railroads are obliged to reduce their big deficits, they are laying off to cut down expenses. This means lowered efficiency instead of increased efficiency which is necessary to cope with the situation. One of the big western railroads only recently laid off 750 men in one of their shops.

"The country had to turn to motor transportation in the emergency of war, and in the emergency of peace, motor transportation is the only relief to which the country can look.

"Business men who want to be sure that their freight will be handled should equip now with sufficient motor transportation. The demand for motor trucks is growing enormously, and business men will have to place their orders promptly if they want to be sure of getting trucks when they need them."

Water Measurement in Boiler Test

ONE OF the chief problems confronting the engineer is to determine which is the best coal for his plant, and this does not always mean that the coal with the highest B.t.u per lb. and that evaporating the most water per lb. of coal under standard test conditions is the coal that evaporates the most water per dollar under daily operating conditions.

The engineer of a certain plant was told by the agent that 3 different coals, a car of No. 1 buckwheat, and a car of coke breeze were in the ward and asked to test these out to determine which to purchase for the coming year, the soft coals and different mixtures being tested.

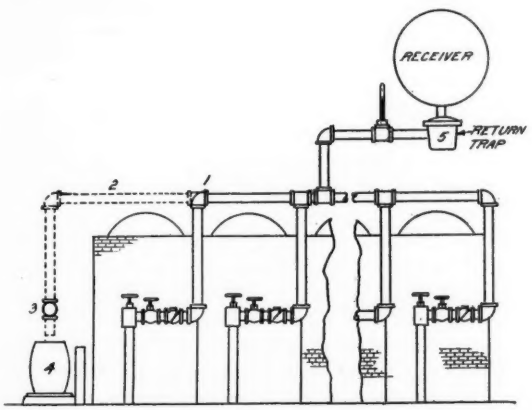


FIG. 1. RETURN WATER PIPING AT REAR OF BOILER

The plant consisted of six return tubular boilers, two of which were sufficient to carry the load when the coals were tested, were equipped with stokers. Coal was weighed in a wheelbarrow in loads of about 350 lb. each. The feed water was measured by means of a flow meter.

The plant runs 9¾ hr. a day with a 30-min. stop at noon. The engineer saw to it that ordinary everyday conditions prevailed as far as possible, the fires being banked at noon and tubes blown each morning. The blowoffs were tight and a string was tied around the water glasses to have the water maintained as near as possible at the same height through the test.

The coal was weighed out in lots containing enough for an hour's firing. The height of the fire at the start of the test was carefully noted and marked on the liner of the fire door and the stoker hopper empty. At the end of the test, the fires were burned to as nearly the same conditions as possible as the beginning.

The results showed that with soft coal containing 13,000 B.t.u. steam 90 lb. gage and temperature of feed water averaging 169 deg. F. the evaporation per pound of coal was 7.5 lb. As this was altogether too low, an investigation was begun and resulted as follows:

Figure 1 is a view of the piping at the rear of the boilers, showing how the condensate for the machines using steam and the heating system is returned into the boilers.

It was with difficulty that we succeeded in convincing the engineer that the return should be weighed and then weight added to the meter reading to get the total weight of water evaporated. To determine the weight of the returns, the el, 1, Fig. 1, was removed and replaced by a tee and the pipe 2 connected into this with a valve, 3, located in relation to the floor as shown.

An empty oil barrel was put on the scales, 4, and its weight empty noted. Opening the valve, 3, allowed the trap, 5, to discharge into the barrel, and, at the end of each discharge, the valve, 3, was closed and the water

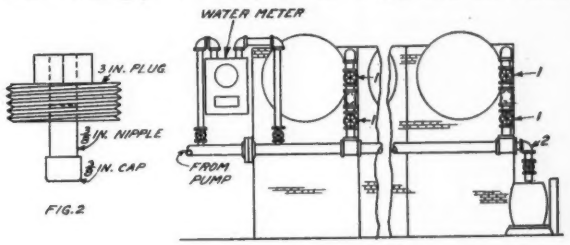


FIG. 2. THERMOMETER WELL

FIG. 3. PIPE CONNECTIONS USED FOR TESTING FEED-WATER METER

weighed, the average weight for 12 dumps being 235 lb.

A spare revolution counter was so located that each dump of the trap was recorded on the counter. A thermometer well made as shown in Fig. 2 was located in the discharge of the trap, 5, and the temperature of the returns read when the other readings were taken.

At the end of the test, the feed-water meter was tested as below, Fig. 3 showing the feed piping. Having ascertained that the feed valves 1, 1, were tight, a nipple and valve was connected into the plug, 2, at the end of the feed line. With the valves, 1, 1, shut and the barrel located on the scales as shown, the feed pump discharged into the barrel, the meter recording the water passing as usual. The water in the barrel was weighed and checked against the meter's reading, which showed the meter to be 1.02 per cent fast which is well within the maker's guarantee. The meter's reading was corrected for this by dividing the meter reading by 1.0102. Water actually evaporated per pound of coal was 9.44 lb. and the equivalent evaporation from and at 212 deg. F. was 9.56 lb. per lb. coal, which is considerably better than was indicated when the returns were not measured.

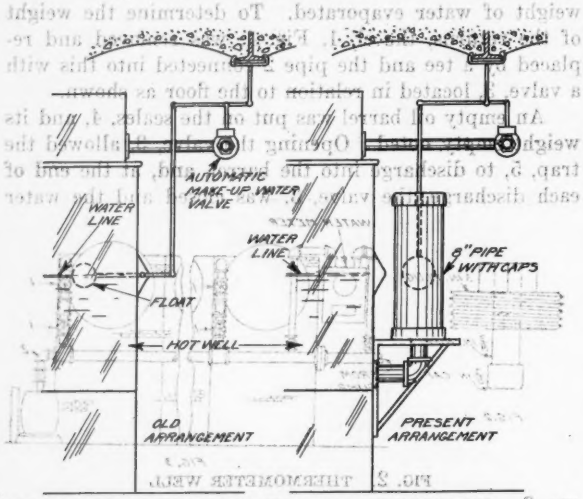
RECEIVER.

Overcoming Heater Float Troubles

THE WATER in any open feed-water heater which is known to be of too small a capacity is given to continuous and violent agitation. This agitation will necessarily impart severe strains to the float operating the automatic make-up water valve and cause untold trouble and waste of time to the man under whose supervision this part of the steam plant comes.

A few years ago a certain concern started business and their steam plant equipment contained an open feed-water heater, at that time amply sufficient to care for their feed-water needs. The water level in the heater was always fairly stationary and for a number of months no float troubles were experienced; but as new steam using equipment was added to the mill with the exhaust lines leading directly to the heater, float troubles commenced. It was a plain case of an overloaded heater.

Repeatedly the chief engineer had to contend with leaky or collapsed floats or bent float stems which, by



FORMER AND PRESENT FLOAT ARRANGEMENT

causing the automatic valve to become inoperative, either emptied the heater through the pump or caused an appreciable loss of water via the overflow. Whenever the float and therefore make-up water valve became useless, the water level had to be maintained by hand and as the heater was some distance from the boiler room, the water tender was too often absent from his duties in the firing isle to please the chief.

When Sunday came, a new float or stem was installed, the heater sealed up and everything once more placed in the hands of the goddess Luck. Such proceedings soon began to run into money and it finally dawned upon the chief that something must be done to eliminate this waste of material and precious Sunday time.

A new heater was out of the question at that time, so he eventually solved the problem as shown in the accompanying sketch. Since the float was installed on the outside of the heater, there has been no occasion for repairs, as the float rests on comparatively quiet water at all times.

NEW YORK.

WAR SAVINGS Stamps represent the ability to save intelligently and invest wisely.

Dangerous Water Problem

IT HAS BEEN with extreme interest, careful thought and study that I have given my attention to the many articles which I have read through our mechanical journals during this past year, and one especially worthy of consideration was published in Power Plant Engineering, Charles L. Hubbard's article in the June 1 issue in reference to drinking systems.

One worthy of being discussed, however, and one which should be most serenuously impressed upon power plant engineers who have charge of water works plants, is the system in which their supply mains are laid through the different streets of towns and cities. More stress seems to be laid on the question of filtering of the water than anything else, and in all probability nine times out of ten, when there is any uproar about impure water, the first thing the health physician does is to make a survey of the plant, winding up by being introduced to the filter, and shown how perfectly it is working. He then proceeds to take a sample of the water, and sends it off for an analysis. The analysis having been made, a report comes back, stating that the water is practically free from all contagious germs. Then our daily papers come out in big headlines, "Analysis of Drinking Water Shows No Contagious Germs," which practically proves to the inexperienced, ignorant or careless engineer that the analysis had been most carefully executed, while, as a matter of fact, it was most incorrectly conducted.

The only method by which a correct analysis of water used for drinking purposes may be obtained is to take, for instance, a street sprinkling truck, wash the tank out thoroughly, and disinfect it thoroughly, then rewash it, and proceed to each street hydrant and draw from it from one to two water buckets of water, place it in the tank and after the water has been drawn from all of the hydrants, then let the health officer take this test water from the tank.

I consider that, if a medical record were compiled in reference to sickness caused and lives lost for one year by impure drinking water, it would create quite a sensation among the populace if not in the medical world. You may talk about boiler and flywheel explosions, electrical accidents and numerous others of a mechanical nature, but I believe that the matter of pure drinking water will stack up pretty well with the rest of them.

I realize that an argument may be presented to offset this statement to the effect that if the water enters the mains pure it will keep so indefinitely, which is good logic; but I beg to offset that theory by the fact that all waters now used are contaminated more or less in some manner, and the idea is to use every possible precaution. I think that this contaminated water trouble could be almost entirely eliminated if the water engineers would see that there are no dead mains in their systems; in other words, the entire system should be so laid and connected that the water would be in complete circulation throughout the entire system, whereas should any germs get through the filter, then find their way into a dead main, they would lodge there and accumulate owing to the fact that presumably there is but little water used from that main unless it would be in case of a fire, which seldom happens.

They will soon migrate and multiply over the entire

main until they find their way to one or more faucets or meters of different residences in the most contaminated form combined with an odorous and bad tasting water caused by the lack of circulation in a much more dangerous stage than if they could circulate through the entire system with all probability that they would be more rapidly washed out of the pipes than if they were allowed to remain, and breed in what is known as dead or stagnant water.

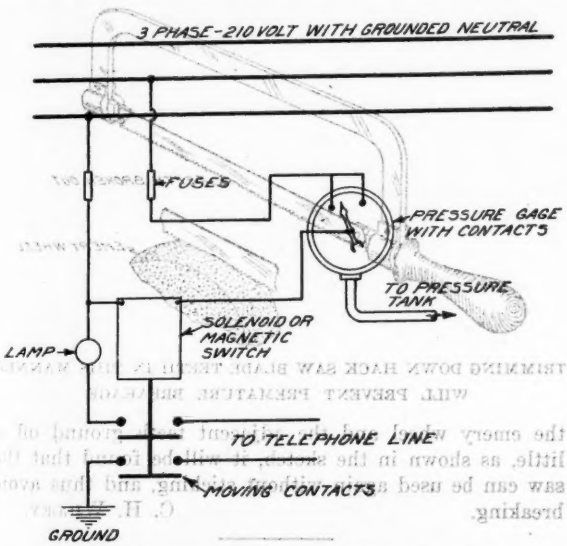
H. W. Rose.

Pump House Warning Signal

The experience which I have had with a small water system might be of interest to others.

A two-stage motor driven centrifugal pump is used to lift the water out of a well 15 ft. deep.

The pump is on surface and delivers water to a 200-gal. tank. The check valve is located at the bottom of the well so that the pump will not lose its suction as the water pressure remains in the pump when not running.



WIRING OF SIGNAL DEVICE

The water pressure ranges from 20 to 40 lb. pressure, stopping and starting of the pump being accomplished by an automatic pressure regulator.

A small air compressor is used about four times a year to pump sufficient air into the tank so that at about 18 lb. pressure the tank will contain only air. This feature assures us of fresh water from the well and it does not have a chance to get warm in the summer time. Another advantage is that the pump does not start and stop so often because the cushion effect in the tank is greater than if the air in the tank was compressed by water only. This also saves the automatic switch and regulator contacts considerably.

It was desired to have some kind of signal to give warning of any trouble that might occur, as the pump house did not receive regular attendance. The importance of this signal can be comprehended when it is known that the water must be kept running in the mains to prevent freezing in the winter months.

Some of the houses which were furnished with water from this station were already connected with a private telephone line which passed by the pump house, and as each resident was interested in the pump's operation, it was decided that a warning could be given to ring the telephone bell in each house and the pump would be sure to receive attention from somebody.

A pressure gage was fitted up with contacts so that whenever the pressure in the tank dropped to 18 lb. or raised above 40 lb. it would close the circuit of a 2-volt magnetic switch. When the magnetic switch closes it connects one of the telephone wires to ground and the other through a 60-watt lamp to one wire of the 210-volt circuit.

The reason that one of the telephone wires is connected to ground is that the transformers which supply this pumping station are connected to the ground with a neutral wire grounded.

The wiring diagram shows only the bell ringing appartus.

L. W. Wyss.

Feed Pump Difficulties

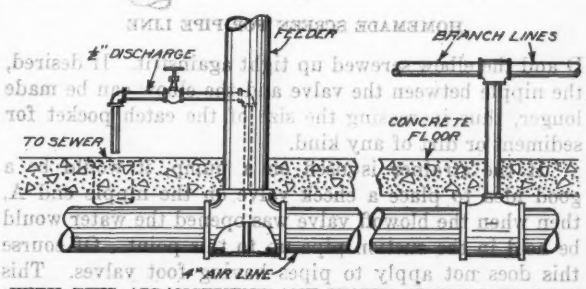
I have been greatly interested in the letters recently published regarding steam feed pump difficulties, as I have been having difficulties with my own. This is a single-cylinder pump, such as described by J. B. J., in the May 15 number. It would thrash and hammer until it seemed as if the feed pipe would break. Temperature of the feed water did not seem to affect it one way or the other. Not finding anything wrong on the steam end, I looked to the water end; valves were all right, also plunger, etc. To my surprise, on starting again the pump operated without any of the former noise. In a few days it started on a rampage again. Then I discovered the gasket in the water end had failed, between the two valve chambers. On renewal the pump again ran quietly. A leaky check valve may cause a pump to balk, also insufficient cylinder lubrication.

L. C. B.

Removal of Water From Air Lines

Shown in the accompanying sketch are the means we employed to remove water from our main air lines.

These lines, as indicated, are carried below a concrete floor, and as a consequence it was impossible to provide drains without considerable trouble. With the scheme illustrated we were, however, able to remove practically all and any water tending to accumulate. The ½-in. line discharging into the sewer is brought to within a fractional part of an inch of the bottom of the 4-in. main. By opening the attached valve any water which may be present is, due to the pressure of the air, forced out.



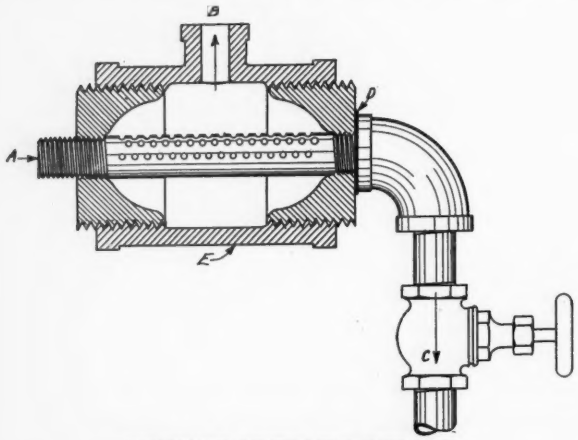
WITH THIS ARRANGEMENT ANY WATER TENDING TO ACCUMULATE MAY BE QUICKLY REMOVED

E. C. Spratt.

Screen for Pipe Line

THE MATERIAL required to make the strainer shown in the sketch consists of one large tee, two bushings and one nipple. Several rows of holes are drilled along the length of the nipple. The strainer is put together as shown. It can be used on suction or discharge pipes for water or otherwise.

Admission is at A, discharge at B, blowoff at C. The thread on the nipple at D should be made very loose, that is, cut very deep, for should the suction pipe be 2 in. and the tee 3 in., it will mean a difference in the threads, and the bush and tee and nipple threads must all go up together on this end when putting the strainer together, to prevent a leak at D. On account of this loose thread, a gasket is used on the nipple at



HOMEMADE SCREEN FOR PIPE LINE

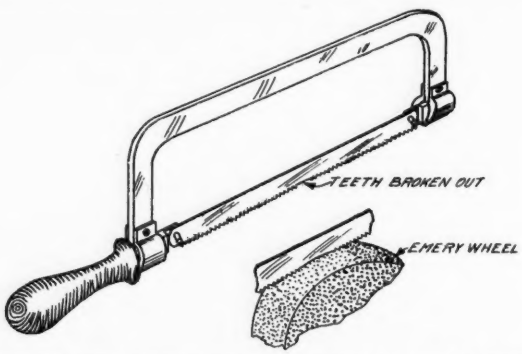
D and the elbow screwed up tight against it. If desired, the nipple between the valve and the elbow can be made longer, thus increasing the size of the catch pocket for sediment or dirt of any kind.

If the strainer is used on a pump, it would be a good idea to place a check valve on the nipple end A, then when the blowoff valve was opened the water would be held in the suction pipe up to this point. Of course this does not apply to pipes having foot valves. This screen will last as long as the pipe line. Where hot water or salt water is used the drilled holes might rust up in time. Under those conditions it would be the right thing to use a piece of brass water pipe for the nipple. If the strainer is to be used on a steam line, the holes should look down instead of up and the tee should be topped at E, for a drip running to a steam trap. The strainer will in this case also act as a separator.

JAMES E. NOBLE.

Preserving Hack Saw Blades

HERE IS a little, but nevertheless important kink that saves many hack saw blades. Most of us, when sawing pipe or tubing, etc., have broken out two or more teeth of the hack saw blade, and when trying to finish the cutting, have succeeded in breaking the blade. If when one breaks out a few teeth, the blade is held on



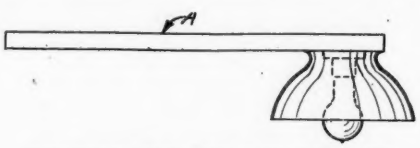
TRIMMING DOWN HACK SAW BLADE TEETH IN THIS MANNER WILL PREVENT PREMATURE BREAKAGE

the emery wheel and the adjacent teeth ground off a little, as shown in the sketch, it will be found that the saw can be used again without sticking, and thus avoid breaking.

C. H. WILLEY.

Utilizing Old Arc Lamp Shades

TODAY IT is a question of using every scrap article that you can lay your hands on. Incidentally, while doing so the cost of installing is cut down. Having withdrawn our arc lamps from active service and installed gas filled Mazdas, we found ourselves well stocked with old lamps. What to do with them was a problem, as we could not seem to sell them. As luck sometimes does, it turned our way, for we had a temporary light-



REFLECTOR USED FOR FLOOD-LIGHTING

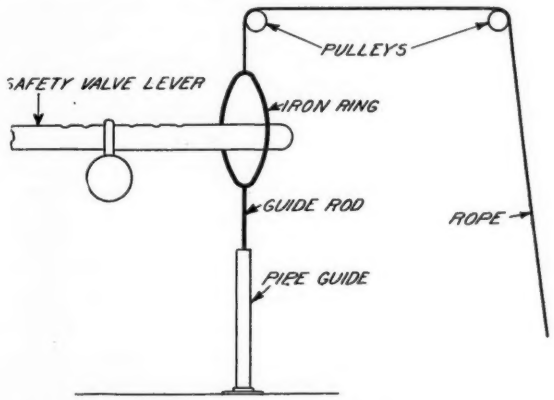
ing job to tackle. As we were to flood-light this also to give general illumination the following scheme was tried and proved a success. We dismantled our old arcs and took the reflectors out and fastened them to a board, as shown in the sketch.

The board was smaller than the diameter of the reflector, as good ventilation was desired for the gas-filled

lamps. On this board we fastened a receptacle, as shown in the sketch. The wires were left long, so that they could be tapped on a circuit within a reasonable distance. By making the board A 4 or 5 ft. long the light could be fastened to a tree, post or building, and could be so arranged that the light could be thrown in any place desired. DEAN B. COBB.

Scheme for Trying Out Safety Valves

THE WRITER visited a plant some time ago where he noticed an unusual arrangement for daily testing the safety valve; it was the desire of the engineer to lift the valve off its seat once or twice a day to make sure it was operative. This involved climbing upon the boiler, so the engineer had rigged up an arrangement as shown herewith. A large wire ring about 8 in. in diameter was placed around the safety valve arm and to the bottom of the ring was soldered a straight iron rod. This rod worked in a piece of 1-in. pipe on the top of the boiler to act as a guide to prevent the ring tangling up in the valve parts. Then at the top of the ring was



ARRANGEMENT OF RING EMPLOYED TO TRY OUT SAFETY VALVES

fastened a cord, running with pulley down to the boiler front, by means of which the ring could be lifted to engage the valve arm and lift it from its seat. The guide on the bottom of the ring was made long enough that if for any reason the cord should break, the bottom of the guide rod would rest on the bottom of the pipe and still hold the ring away from the valve arm.

The engineer was working his arrangement every day and regarded it highly as a "lazy" man's kink.

M. A. SALLER.

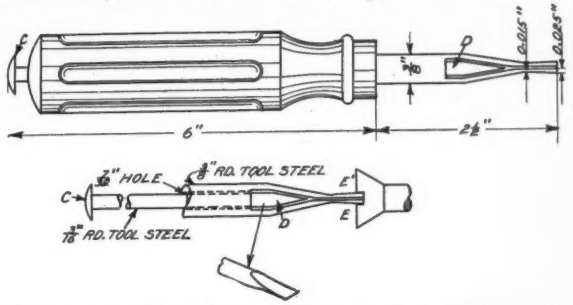
A Pneumatic Pump Agitator

TO ELIMINATE considerable trouble experienced with sediment gathering directly under the suction opening of air pump, with the result that this would get into the pump and require frequent cleaning, we employed the following arrangement: A 1¼-in. airline containing a comparatively great number of ⅛-in. holes was placed at the bottom of the well in such a manner as to cause the air to discharge directly below the pump suction opening. This prevented further accumulation of sediment, and while it had the disadvantage of making it necessary to shut down the pump each time the air was blown (the tendency of the air being to destroy suction created), it saved considerable labor and expense otherwise required for the cleaning of the pump.

E. C. SPRATT.

A Screw-Holding Screw-Driver

BY MEANS of the unique screw-driver shown in the accompanying illustration screws up to 6/32 by 1½ in. may be securely held preparatory to driving. Essentially this driver consists, in addition to the handle, of a 3/16-in. tool steel pusher rod one end

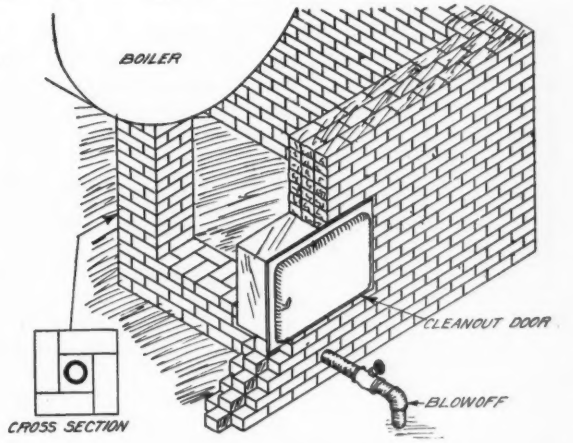


DETAILS AND ASSEMBLY OF SCREW-HOLDING SCREW-DRIVER

of which is of wedge shape while the other is fitted with a round head, and a ⅜-in. tool-steel shank with split tapered ends E and E′. These, as indicated, also taper for a distance of ⅜ in. from 0.025 to 0.015 in., this scheme being employed for the purpose of facilitating the wedging effect of D, as this upper pressure at C is forced forward, causing a spreading of E and E′, within the screw slot, and in that way more firmly securing the screw. OTTO DORTHEN.

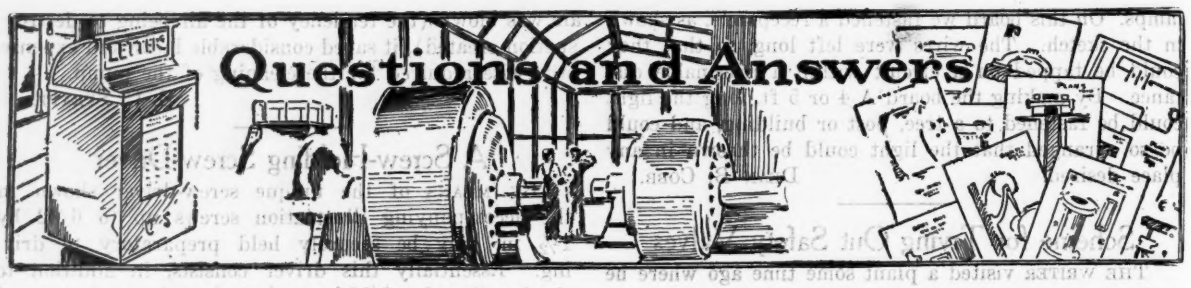
Protection for Blowoff Pipe

THE ACCOMPANYING drawing shows the kind of blowoff pipe protection I use in my plant. With this protection around blowoff pipe, none of the hot gases can strike the pipe, which remains cooler, as there is



FIRE BRICK SHIELD FOR BLOWOFF PIPE

more or less air drawn in around the blowoff pipe. When doing any repair work, the brickwork is taken down, and in rebuilding it there is no mortar used. In my 15 yr. experience I have never had any burned blowoff pipes. L. A. COLE.



Why This Emptying Reservoir

IN A PLANT where I worked we had an odd experience that has been a mystery to myself and a few others and I would like to hear from readers who have probably had the same experience or from others as to the solution of the problem.

We had a water softening plant which overflowed into a large concrete reservoir which at times would run low. To fill it we used raw water through an idle barometric jet condenser. This kept the pipes sweating, so we hit on the idea of taking the make-up water from the discharge of a turbine-driven centrifugal pump for our surface condensers. This was a 12-in. line and we put on a saddle flange for a 6-in. line to the reservoir and thought our troubles were over. We started to use the new arrangement and shortly after our service pumps began to race and pound we discovered that the reservoir was empty and no water coming from the 6-in. line, but instead it seemed to be sucking in air. After filling the reservoir, we tried it again and watched the water leave the reservoir faster than all our pumps could take it out. After this experience, we continued the practice and resolved that we still had something to learn. The pump worked under a 35-ft. head, forcing the water through the two condensers and out by gravity to the river, 50 ft. below. R. A. F.

Setting Locomotive Valves

J. S., WHOSE REQUEST for information regarding the method employed for the setting of valves on a Vanclain locomotive appears on page 564 of the June 15 issue, will undoubtedly be interested in the following information I have compiled from various works in my library supplemented by my personal experience in railroad engine work.

The principal features of the construction of the Vanclain compound engine are, to my best knowledge, the cylinders, one high-pressure and one low-pressure for each side, the ratio of volumes of which are as 3 to 1. They are cast in one piece with the valve chamber and saddle, the cylinder being in the same vertical plane and as close together as they can be, but with adequate walls between them. Where the front rails of the frames are single bars, the high-pressure cylinder is usually put on top; but when the front rails of frames are double, the low-pressure cylinder is usually on top. The former is used in 8-wheel or American type passenger locomotives, and on 10-wheel locomotives, while the latter is used in mogul Consolidation locomotives. For the various other classes of locomotives, the more suitable arrangement is determined by the style of the frames.

The valve system employed to distribute the steam to the cylinders is the piston type working in a cylindrical steam chest located in the saddle of the cylinder casting between the cylinders and the smoke box, and as close to the cylinders as convenience will permit. The steam chest is bored out larger than the diameter of the valve to permit the use of a hard cast-iron bushing. This bushing is forced into the steam chest under such pressure as to prevent the escape of steam from one steam passage to another except by the action of the valve. The valve, which is of the piston type, double and hollow, controls admission and exhaust of both cylinders. The exhaust steam from the high-pressure cylinder becomes the supply steam for the low-pressure cylinder. As the supply steam for the high-pressure cylinder enters the steam chest at both ends, the valve is in perfect balance except the slight variation caused by the area of the valve stem at the back end. This variation is an advantage in case the valve stem or its connection to the valve rod should be broken. Cast-iron packing rings are fitted to the valve and constitute the edges of the valve. They are prevented from entering the steam ports of the bushing when the low-pressure cylinder is on top. The double front rail prevents the use of the ordinary rock shaft and box and the valve motion is then what is called direct-acting, changing the location of the eccentrics on the axle in relation to the crankpin. When the low-pressure cylinder is underneath the rock shaft and the eccentrics are placed in the usual position, the valve motion is termed indirect acting.

Great care should be taken by mechanics when setting the valves on these locomotives to observe this difference and not get the eccentric improperly located on the axle. If the crankpin is placed on the forward center the eccentric rods will not be crossed when the rocker arm or indirect motion is used. Serious complications have arisen from this being disregarded and various methods have been employed to transfer the motion from the links to the valve rod, the most commonly used being a small crosshead sliding between two guide bars. It is preferable to use a rock shaft when possible as there is less departure from ordinary locomotive practice. It is obvious that in starting these locomotives with full trains, it is necessary to admit steam to the low-pressure cylinder as well as to the high-pressure cylinder which is accomplished by the use of a starting valve. This is merely a bypass valve, which is opened to admit steam to pass from one end of the high-pressure cylinder to the other end, and thence through the exhaust to the low-pressure cylinder. The same cock acts as a cylinder cock to the high-pressure cylinder and

is operated by the same lever that operates the ordinary cylinder cocks, thus making a simple and efficient device and one that need not be disarranged.

As is usual in all engines, air valves are placed in the main steam passage of the high-pressure cylinder with additional air valves placed in the low-pressure cylinder to supply them with sufficient air to prevent the formation of a vacuum which would draw cinders into the steam chest and cylinders. Water relief valves are applied to the low-pressure cylinders and attached to front and back cylinder head to prevent rupture in case of carelessness and to relieve excess pressure of any kind. In other respects the locomotive is the same as the ordinary single expansion locomotive.

For a further refinement of the valve setting, going beyond the shop marks or mechanical methods, such as by using a tram, I would suggest the use of a good indicator. Setting the valves up to any shop marks or according to mechanical rules does not necessarily mean that we will acquire the proper working proportions of steam into the cylinders, owing to the fact that we may have too much lap or not enough lead caused by the wear of both the valve and the seat itself, and thus correction can only be obtained by the method of taking a picture of the exact working processes which the steam undergoes while in the cylinder, and from that indicator diagram or picture we may make the necessary corrections, thereby obtaining the most economical operating results.

In indicating railroad engines, a great deal of attention should be paid to the reducing motion, as the jarring of the engine will greatly interfere with the correctness of the diagram. The reducing motion generally employed is a lever which is made solid and well secured to the crosshead and at its stationary point the indicator likewise has to be fastened more than is practiced on stationary engines, as fastening it by its cylinder coupling would not be sufficient, and it would be almost impossible to keep the pencil upon the paper. The operator is protected by a sheet-iron box surrounding the front of the boiler, and both cylinders. H. W. Rose.

Variation of Voltage

Voltage variations are generally caused from the following defects: first, irregular speed. G. I., in his communication in the June 15 issue, says he has fairly good speed, therefore his trouble evidently does not center in that phase. Second, bad joints in a belt would have a considerable influence in causing a fluctuation of voltage, and possibly some flickering of the lights. If so, the trouble can be corrected by using a soft, pliable belt, one of the endless type (if the one now in use is hard and has belt buckles or lacing in it which cannot all be removed), properly cemented together, having splices so as to give it one continuous, smooth bearing surface. Any other style of belt will not give the results desired.

Third, should his trouble not lie in the belt, short circuits or disconnections in the armature circuit or short circuits or disconnections in the field magnet circuit may be the cause. If his trouble lies there, it can only be positively determined by a correct test of the entire machine. Short circuits or disconnections will, where either of these faults is present, produce a periodical fluctuation of voltage accompanied sometimes by sparking at the brushes. We shall take it for granted that this is not the case as he has tested out his generator and has located nothing there, and for that reason that part of the machine must be in good condition.

I wish, however, to call his attention to the fact that a dynamo is liable to be overloaded through leakage of current caused by bad insulation of the machine or external circuits, in which case the ammeter will probably not indicate the fact. To ascertain whether this is the case, connect a piece of insulated wire to one of the terminals of the machine while running, and then make short momentary contact with the ground through a water pipe or frame of the dynamo or other body in good connection with the earth. If a flash occurs, it proves that somewhere the insulation is defective. The test should be applied to each of the terminals in turn. The fault should next be located by taking the mains to the external circuit out of the terminals of the machine and again testing as before. If a flash again occurs, it proves that the defect exists in the dynamo, and the terminals should then be tested with a battery and a galvanometer. It must be clearly understood that a fault of this description is just as likely to occur in the external circuit, and if, therefore, after removing the mains from the terminals of the machine, and again testing, the flash disappears, it may be taken that the fault is in the external circuit, which should be tested in a similar manner.

G. I.'s omission to state whether the heating up of the machine had always been its custom, or whether it has developed only since he overhauled it, leaves me at somewhat of a loss as to just how to diagnose that feature of it. If this, however, is not the normal temperature of this machine, there is an improper outlet connection somewhere preventing current from getting out of the machine, which causes this heat. It may be due to the fact that considerable oil was left between certain connections or parts when they were screwed back together, thereby offering excessive resistance, and it may also be possible that his recording instruments are faulty in certain respects, due to vibration, if any, and numerous other facts which will throw them out. I would recheck my instruments, and ascertain whether they are recording correctly.

Passing on from that feature of his trouble, if I were going to proceed to locate this irregularity, I would first take it for granted that his entire electrical system was in good working condition, and would next proceed directly to the exciter, of which he states he has turned down the commutator. If this piece of work was not performed by a good machinist or by one having had considerable experience in repairs of this kind, he will undoubtedly locate his entire trouble there. Many a machinist will ignorantly place an armature in a lathe, turn the commutator up at high speed, then chalk his file, and proceed to smooth the surface. No lathe cutting tool will, as a rule, turn off equally the mica segments with the copper. The mica has a tendency to dull the tool at every revolution, and also to throw the tool away from the copper every time it comes in contact with it. Whenever a commutator is turned, always see that the machinist takes his lathe tool after he has completed his work, and

grooves down the mica of every segment until it is at least 1/64 in. low.

The reason for doing this, although it is not perceptible to the eye, is to allow the brushes to come into perfect contact with commutator, and if not you will not only have a heating commutator, a rapidly cutting one, but from various loads, and the normal speed of the machine combined, have a tendency constantly to throw the brushes away from the commutator, which will sometimes damage your generator to the extent of not being able to generate any current at all. High mica should always be cut down, and continually kept down; a machine with high mica in the commutator of the exciter will cause irregular voltage as much as anything else, and I am firmly of the opinion that all of his trouble will be located in that spot as it generally is in troubles of this nature. H. W. ROSE.

I WAS MUCH INTERESTED in G. I.'s query concerning low voltage on his alternating-current generator. I have had the same experience with two machines, each of 125 kw., 440 v. The voltage would drop about 20 v. and by cutting the other exciter in parallel with the one running, it would hold the voltage, or if I started the other machine, cut it in and cut the other one out. It would hold the voltage, and either machine would carry the same load during the night and maintain its voltage. As soon, however, as the machine became well warmed up, the voltage would drop.

My load consisted of induction motors driving centrifugal pumps, which gave a rather low power factor. G. I. did not state the nature of his load, the hours of work, nor whether he had a wattmeter or not, which he should by all means have on a load of that character; then, by multiplying his ampere reading by the voltage and $\sqrt{3}$ for a 3-phase circuit, he could compare it with the wattmeter reading and get his power factor and the wattless current. The wattless current heats his machine, thereby causing his low voltage; if he has plenty of excitation and a steady load, he can cut out the voltage regulator and regulate the voltage by the exciter rheostat; but be Johnny on the spot if they drop the load. N. W. DUELL.

Oil Engine Lubrication Problem

IN REGARD to the oil engine lubrication problem of T. C. P., as published on page 519 of the June 1 issue, in my opinion there are at least five different conditions that might cause his trouble, which I have named below.

First, too rich a mixture which carries more oil into the cylinder than can be burned by the quantity of oxygen present, the excess fuel oil remaining in the combustion chamber to be distributed over the piston head, valves and combustion spaces, where it remains and the heat vaporizes the volatile parts of the oil, leaving the residue to bake and form carbon.

Second, too light a grade of cylinder oil or an inferior grade of oil with too much carbon in it.

Too light a grade of cylinder oil will over lubricate the engine, leaving a small quantity of lubricating oil in the combustion chamber and passages to burn and cause carbon.

I hardly think it necessary to try to enumerate the evils that follow the use of an inferior grade of oil or one not designed for the lubrication of an internal combustion engine.

Third, worn cylinder or leaky rings which will let even the best of oil work past the piston and accumulate in the combustion spaces to burn and leave carbon. Carrying the oil level too high in an engine using the splash system of lubrication will have practically the same effect and may be mentioned as the fourth cause.

Fifth, faulty cooling on account of scale or sand in the water jacket, causing the engine to overheat; but it is more likely one of the other reasons, as an engine properly lubricated with a good grade of oil and with the mixture kept as lean as possible, can be run pretty hot and not harm the engine in any way.

In fact, the hotter you can run an engine and still keep it properly lubricated, the more power you can get out of your fuel. But right there is where we strike a snag, for we have no oil capable of standing a high temperature and still properly lubricating the engine. If we run our engine so that the cooling water temperature at the outlet is about 180 deg. F., we will get the best results from our oil and long life from the engine.

A letter to the engine makers will bring you far better advice about what kind of oil to use and how much than any of us can give you.

Make your mixture as lean as possible, and if you will take your rings out and file the upper edge off a little, it will often cure your excessive oil trouble. The beveled edge has a tendency to ride over the little globules of oil and as the piston comes down the square edge scrapes most of the excess oil back down into the crank case. C. C. LINCOLN.

Preventing Boiler Vibration

IN REFERENCE to the vibration in J. H. P.'s boilers, as mentioned on page 473 of the May 15 issue, I have experienced the same trouble in three plants, all using high-speed engines. The fact that the steam pipes were too small caused the trouble. The steam came from the boilers in puffs the same as from the exhaust pipe. The remedy is to enlarge the steam pipe, or place an enlarged section of pipe just above the throttle, which makes a reservoir for steam.

J. H. P. can determine whether this is the cause of the trouble by closing the throttle slowly until the steam is partly cut off. S. G. M.

Injector Operation Troubles

WHERE do you generally find trouble with an injector when it refuses to operate? The water continues to flow into the overflow pipe and no doubt you will say, "Cut down the water supply." This has the desired effect, but a supply of water is cut so low that it is not enough for the boiler and the injector is not working to its full capacity. I would say, about ⅓ of its capacity.

Also inform me what parts of the injector are liable to wear. I have tried every trick I know of, and can see no wear on the different parts.

A. The point where you would perhaps find considerable trouble in injectors is in the jets and the overflow valve. Eventually jets, if they do not become

worn, will have a tendency to become limed up, and as a consequence the passages may not only become contracted, but considerably irregular, resulting in very erratic operation of the injector.

We would suggest that you take your injector apart and examine the interior of these various nozzles. If you find that they contain any lime, soak them in a solution of one part muriatic acid to five parts of water, until the lime is removed. If you still continue to have trouble you might examine the overflow valve. This may either be limed up, or it may be badly worn.

You state that you have already examined your injector, and find that apparently no wear has taken place. We do not want to question your statement; but you will realize that, due to the action of the water, the interior of the nozzles may be worn in such a manner that you might not recognize the wear. If, after you have taken apart your injector, thoroughly cleaned out and removed the lime in the manner we have stated above, and reground your valves, you still find that the injector does not work satisfactorily, then we would be led to believe that your trouble was due entirely to the wear of the nozzles.

Cleaning Compound Formulas; Refrigerating Plant Questions

WHAT might I use for the cleaning and polishing of burned steel work on engines?

2. How are refrigerating machines and compressors used for ice making rated?

3. How may the required temperature of cooling water for use in connection with an ammonia condenser be determined? W. P. S.

A. To 20 parts of water add 2 parts of alum, 2 parts of Tripoli and 1 part of nitric acid, or to 40 parts of water add 2 parts of oxalic acid and 7 parts of Tripoli. Either one of these mixtures, we are sure, will readily remove burned oil from the metal surfaces of your engines.

For polishing, use the following composition, which will prove entirely satisfactory: To 1 part oxalic acid, add 12 parts Tripoli, 20 parts of the best powdered pumice stone, 60 parts of palm oil and 4 parts of petroleum or oleine. Perfume with mirbane oil.

We might, also, recommend the following: Take equal parts (by weight) of ferrous sulphate (green vitriol) and sodium chloride (cooking salt); mix both well together by grinding in a mortar, and subject the mixture to red heat in a mortar or a dish. Strong fumes will develop and the mass will begin to flow. When no more fumes arise, the vessel is removed from the fire and allowed to cool. A brown substance is obtained with shimmering scales, resembling mica. The mass is now treated with water, partly in order to remove the soluble salt, partly to wash out the lighter portions of the non-crystallized oxide, which yield an excellent polishing powder. The fire must be neither too strong nor too long continued, otherwise the powder turns black and very hard, losing its good qualities. The more distinct the violet brown color, the better is the powder.

2. It is customary to rate refrigerating machines in tons of refrigerating capacity in 24-hr. on the basis of a suction pressure of 15.67-lb. gage, corresponding to zero degree F. temperature of saturated ammonia vapor and a condensing pressure of 185-lb. gage, corresponding to 95.5 deg. F. The actual capacity increases with the increase of the suction pressure, and decreases with the increase of the condensing pressure.

Compressors used for ice-making purposes must be of from 40 to 50 per cent greater capacity than those used for refrigeration, due to the fact that, in ice-making, the water must be cooled from the temperature at which it leaves the cooling coil, say 85 deg. F, to the temperature of the freezing tank, which may be 14 deg. F, and in addition to this extract 142 deg. F of latent heat for each pound of ice.

Exact size of compression cylinders for any given refrigerating capacity cannot be given unless the temperature to be maintained in this cooler be known. For general purposes it is safe to say that a compressor having 7500 cu. in. capacity per minute will handle sufficient gas for one ton of refrigeration during a continuous run of 24 hr. This rule is based on an expansion pressure of 15-lb. gage, with cooling water at 70 deg. F. If the pressure in the expansion coils varies from 15lb. the number of cubic inches of cylinder capacity required for one ton of refrigeration will also vary.

The expansion pressure always varies with the temperature to be maintained. The following table of temperatures, expansion pressures and cylinder capacities will be useful in estimating the capacity of compressors:

Lowest Temp. to Be Maintained.	Approx. Temp. of Suction Gas.	Suction Pressure Gage.	Cu. In. of Cylinder Per Minute.
Deg. F.	Deg. F.	Lb.	
— 5	—17	5	10.700
0	— 8	10	9,000
+10	0	15	7,500
+15	+ 6	20	6,000
+20	+11	25	5,400
+25	+17	30	4,800

In this table, for convenience, the temperature of the condensing water is assumed to be 70 deg. F. For every 5 deg. variation in the temperature of the condensing water above or below 70 deg. F., add or deduct 1 per cent to or from the number of cubic inches of cylinder capacity given.

In every case the lowest temperature to be maintained in any part of the plant must be taken to estimate the required cylinder capacity.

To find the refrigerating capacity of a compressor at any given pressure, multiply the area of the piston, in square inches, by its stroke, in inches, and the number of strokes per minute, and divide by the number of cubic inches given opposite the gage pressure in the table above. The result will be the capacity of the compressor in tons per 24 hr.

3. Knowing the head pressure carried, it is necessary to secure the corresponding value of temperature of the ammonia as may be obtained from a table of the properties of saturated ammonia. It is usual, then, to carry the temperature of the cooling water about 10 deg. lower than this.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Office
(Established over 23 years.) Formerly PRACTICAL ENGINEER
PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

BY THE TECHNICAL PUBLISHING CO.
537 South Dearborn Street, Chicago
New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1919, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Circulation of this issue 22,450

CONTENTS

U. S. Nitrate Plant No. 2. By Edward R. Welles and W. A. Shoudy. Illustrated....617
Fuel Conservation Letters. By Joseph Harrington. Illustrated....623
Boilers and Auxiliaries....624
Novel Balloon Landing. Illustrated....627
Mortimer E. Cooley. By J. R. Bibbins. Illustrated....628
Efficiency of Liquid Fuel. By Lindon W. Bates....630
Heat Loss Due to Scale. By F. F. Vater. Illustrated....631
Are Steam Traps Machinery? By Theodore Haight. Illustrated....632
Largest Aircraft Engine....634
Power Factor Correction. Illustrated....635
Safety Suggestions for Electrical Workers....638
Possibilities of Steam Railroad Electrification. By Calvert Townley. Illustrated....639
One-Handed Methods. By H. A. Cranford....642
Deterioration of Ice Plants. By Fred Ophuls....644
The Proposed Department of Public Works....646
Letters Direct from the Plant: Water Measurement in Boiler Test. Overcoming Heater Float Troubles. Dangerous Water Problem. Pump House Warning Signal. Feed Pump Difficulties. Removal of Water from Air Lines. Illustrated....647
Successful Kinks from the Power Plant; Screen for Pipe Line. Preserving Hack Saw Blades. Utilizing Old Arc Lamp Shades. Scheme for Trying Out Safety Valves. A Pneumatic Pump Agitator. A Screw-Holding Screw-Driver. Protection for Blowoff Pipe. Illustrated....650
Questions and Answers: Why This Emptying Reservoir? Setting Locomotive Valves. Variation of Voltage. Oil Engine Lubrication Problem. Preventing Boiler Vibration. Injector Operation Troubles. Cleaning Compound Formulas; Refrigerating Plant Questions....652
Editorial: Engineering, Business, Efficiency and Happiness. Higher Steam Pressures....656
Two-Speed Gear Box for Stokers. Illustrated....658
Convenience, Safety and Eye Comfort....658
News Notes....658
Books and Catalogs....660

Engineering, Business, Efficiency and Happiness

That seems like a good title for an editorial. It certainly gives scope for any amount of ability and doesn't tie the editor down to arriving at any particular conclusion or destination.

So many years ago that the editor dislikes to count back, he rashly made a statement in a meeting of teachers of engineering that an engineer's job should be one-third scientific profession and two-thirds business. This was supposed to be knocked into a cocked hat and the maker of the statement utterly squelched by the quoting of somebody's definition that a professional man was one who worked to guard the interests of others; while a business man was concerned only with his own interests.

The years have certainly changed our thought in regard to business, for Service is the watchword of practically every successful business man now-a-days. And certainly the members of at least one "learned profession" are not unmindful of their own welfare, even though they are engaged in serving their clients.

Engineering has changed also. It is less a matter of scientific and mathematical calculation, more a matter of judgment and commercial knowledge. The engineer must determine not only whether it is possible to build a structure or a machine, but must answer the questions, "Is that the best thing to do?" and "Will it pay?"

Primarily the work of the engineer is to make a given amount of energy do the most possible work, or to do a given piece of work with the least energy cost. In this he must balance the costs of various forms of energy against the amounts which must be expended. And as human energy is, in civilized countries, the most expensive form, the problem usually becomes one of replacing human effort by other forms wherever possible, particularly for heavy muscular labor and for monotonous repetition.

There is always the added question of more rapid production, but this again means a less expenditure of energy for a given quantity of product.

So far as the individual is concerned, he wants to finish his day's work with enough reserve of energy to be able to enjoy life and take a reasonable part in the activities of the community. But he wants his work to bring sufficient return so that he and his family can have the wherewithal for enjoyment. The first desire seeks short hours and freedom from exhausting toil; the second seeks high wages. Both are natural, legitimate desires, but to a certain extent are in conflict, and a balance must be struck between them. Neither is served by limitation of production.

In seeking a solution of the problem of reduced exertion—i.e., less energy expended—vs. more effective returns, it is essential to remember that those who work to produce and transport commodities—farmers, miners, weavers, shoemakers, carpenters, clerks, railway or steamboat men—are also those who buy and use commodities. If the cost of growing wheat is increased by reducing the hours and increasing the wages of farm laborers, or the cost of transporting it is increased by a like course for railroad workers, all the rest must pay more for bread. And the same is true with regard to any other necessity or luxury—stoves, clothing, shoes, houses, meat, automobiles, candy, sodas and movies. Prices must de-

pend on the cost to produce, which in the final analysis is almost entirely labor cost—i.e., cost of human energy.

If, therefore, the cost of everything is increased in the same proportion by increasing of wages, the net result has been no gain to anybody. If production is reduced by a shortening of hours, less commodities will be produced and somebody must go without. The ultimate end of this policy would be nobody working at all, nothing produced, and no commodities for anybody. Though there would be plenty of leisure, there would not be much happiness.

The job of the engineering profession is to increase human effectiveness by developing machinery and methods which will make possible shorter hours, with decrease of hard labor, so that the worker may increase his output, hence the returns for his work without increasing cost of production. Energy must be saved at every point—fuel, heat waste, friction, wasted effort, wasted material—all must be cut to a minimum, and the low cost energy of coal, water power and animal power used in place of the high cost human energy wherever possible.

Other professions may contribute to this end, but on the engineer falls the burden of the solution. And to the mechanical problem is now added that of management. Spite of the traditional opposition of interest of "capital and labor," it should be evident that neither can accomplish results without the other. Labor alone has as equipment only bare hands and a brain. To the extent that a man owns his own tools he becomes a capitalist. For modern industry he must have machines, buildings, stores of raw material, and capital must be supplied in large amounts. The most common method of getting it is the stock corporation in which many contribute their savings to supply the capital and receive shares of stock as evidence of their part ownership in the equipment.

Management must establish a just and satisfactory relation between those who furnish the capital and those who furnish the labor which go to produce commodities. As it is the work of the engineer to devise the structures and machines which will assist production, hence to serve capital, and as it is his function to improve methods of operation and do away with waste motion and hard muscular effort, hence to serve labor—it is also his job to assist management so that the human friction between employer and employe shall be reduced to a minimum. The problem is greater than that of the individual plant. It includes shorter hours, better working conditions, doing away with idlers and ineffectives in all industries. It requires that emphasis be placed on the production of sufficient necessities so that all may be amply supplied, and reduction of production and exploitation of luxuries for the few.

What has this to do with happiness? Most unhappiness is caused by the desire to have something that somebody else has. The necessities for comfortable living are comparatively few. Desire for luxuries can be increased without limit, but does not bring increase of happiness. To secure abundance of necessities, resulting in low cost; to reduce luxuries, the desire for them and the striving for them; to increase the accessibility of simple comfortable recreation and pleasures; all these will assist in increasing the happiness of humanity and in solving the economic problems which are now so insistent throughout the nation and the world. A higher standard of comfort during hours of work and leisure for the great number of workers; a less expensive standard of living and display for the wealthy will be of benefit to all, and will contribute to the efficiency of all.

The problem of the individual is to square his ambitions and efforts with these fundamentals, and to try to bring others to a like course.

Higher Steam Pressures

Although steam pressures up to 350 lb. gage are already being employed in a number of instances, it is quite evident from the consensus of opinions expressed by many of the foremost engineers and operators at the recent convention of the National Electric Light Association that as yet the limit has not been reached. Pressures of 500 and 600 lb. gage are now being referred to as were 200 and 250 lb. but a few short years ago, and who will venture to deny the possibility of the future employment of pressures up to 1000 lb. gage?

When such pressures will become common practice, we can, of course, not prophesy, but come they will. In fact, if the ever rapidly increasing costs of labor and fuel are to be combated in even the slightest degree, steam pressures greatly in excess of those employed today will become not desirable, but absolutely necessary. True it is that our present day power station apparatus is wholly inadequate to withstand such extreme pressures, but with the employment now in England of boiler steels having a tensile strength of 74,000 lb. per square inch, the utilization of welded piping systems and the development of the turbine leaves but little room for doubting the ability of designers of such equipment to meet whatever requirements may be exacted.

Eskil Berg, in a paper presented before the Western Society of Engineers, gives considerable attention to the advantages of high pressure steam, and by means of tables, points out the theoretical gain to be realized. Basing his calculations on a pressure of 200 lb. absolute, with the steam expanded to 28½ in. vacuum, he has shown that by the employment of 500 lb. absolute, a net saving of 14.43 per cent of the fuel is possible, while if the pressure be increased to 1000 lb., this factor will become 22.6 per cent, or in the first case a saving of about $200,000 a year in a plant burning 900 tons of coal a day at a cost of $5 a ton.

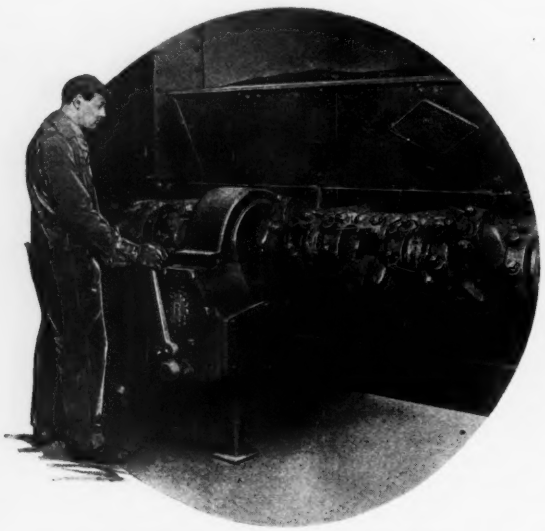
Higher steam pressures are desirable, and necessary.

U. S. Civil Service Commission announces an examination for lubrication engineer, for men only, July 29. A vacancy in the office of the Director of Air Service, War Department, Washington, D. C., at $1800 a year, and vacancies in positions requiring similar qualifications will be filled from this examination. The duties of this position are such that the appointee should have a fair knowledge of organic and inorganic chemistry; he should be able to make qualitative and quantitative analyses; he should be able to compound oils and greases; and he should know the functions of lubricants as used in airplane and motor engines, the sources, kinds, and distillations of crude oils and the different tests and be able to make them. Apply to Form 1312.

Two-Speed Gear Box for Stokers

THE new Riley two-speed gear box differs from the regular design of stoker gear boxes in that it contains, in addition to the worm gearing, a double set of spur gears. These gears are so arranged in the bottom of the gear box that by shifting the lever from high to low speed position or vice versa the coal feed may be retarded or accelerated. It means that on large units the fire can be leveled, thinned, or thickened, as required.

When a number of stokers or gear boxes are driven by a single prime mover, any stoker or the retorts on any gear box can be operated practically independently of all other stokers or gear boxes. This effects a saving in fuel, since there is no necessity for carrying over coke when trying to divide the load equally among a number of stokers, or when building up thin sections of the fuel bed in a wide furnace.



APPLICATION OF TWO-SPEED GEAR BOX

With the stokers driven by an ordinary engine or motor, double the usual range of speed is obtained. This is an advantage at high ratings (300 to 350 per cent). The stoker counter-shaft at these loads usually has a speed of from 400 to 450 r.p.m. Suppose, for example, the load is suddenly reduced to about rating on the boilers. An engine, to handle this, would need to operate from 100 to 150 r.p.m. Such low speeds are not only liable to stall the engine but are extremely wasteful of steam. Shift the two-speed gear box lever from high to low speed and the engine can operate from 200 to 300 r.p.m., an efficient speed for economical operation.

The installation of the two-speed gear box makes the slip ring induction motor more suitable for stoker drive. A 2 to 1 reduction in speed is all that can be obtained electrically but with this new device an overall range of speed of 4 to 1 is obtained. A multispeed motor with four speeds, 600, 900, 1200, and 1800 r.p.m., can now give the equivalent of 300, 450, 600, 900, 1200, and 1800 r.p.m. If the motor operates at a maximum of 1800 r.p.m. during peaks—then a sudden change in steam requirements does not necessitate feeding an excess amount of coal to the boiler. A single throw of the shifter lever from left to right cuts the coal supply in half. This is done without a change in the speed of the motor.

The illustration shows the simplicity of an installation. Note particularly that all gear boxes are driven from one through shaft. It is therefore obvious that all sprockets and chain connections, chain guards, countershafts, and bearings usually required for each gear box are eliminated. Each stoker with the new Riley two-speed gear box has but one chain connection. With large units this saves a great deal of mechanism underneath the stoker.

At the Camden plant of the Public Service Electric Co. of New Jersey it was found that by using the two-speed gear box the stokers could be set much lower. In fact, the bottom of the box can be set directly on the floor. This is an economical advantage with low set boiler, since it enables the stoker to be set low, giving maximum combustion space for the gases.

The use of this additional regulating feature does not interfere in any way with the continued use of any automatic regulating device; in fact, it allows a more intelligent use of any automatic regulator on the stoker drive.

Convenience, Safety and Eye Comfort

IN every plant there are many places which make the need of an efficient portable electric light imperative. In engine pits, under machines and automobiles, in warehouse pits—places not lighted under ordinary circumstances—the Flexco split handle portable guard carries the light safety and handily. This new product eliminates fire hazard because it does away with the careless use of torches and lighted matches in out-of-the-way places where a light is often needed.

The three advantages of this ingenious contrivance are: taking the light where wanted because it is portable; protecting the bulb from breakage; reflecting the light away from the eyes of the user and toward the work to be illuminated.

The guard is made of expanded steel, well coated with tin. The split handle is adjusted by means of screws, and hinges with the guard as a base. It clamps over the socket of an extension or drop cord without re-wiring, the cord running through the groove in the split handle.

News Notes

F. H. MASON, 614 Moffat Building, Detroit, Mich., will represent the Steam Motors Co., Springfield, Mass., in the Detroit district, it has recently been announced.

SAMUEL F. JOOR, Consulting Engineer, of Chicago, has joined the American Steam Conveyor Corp., Chicago, in a capacity of Sales Engineer.

THE WALTER A. ZELNICKER SUPPLY CO., of St. Louis, has added 2000 sq. ft. to its present office space at 325 Locust St., St. Louis, Mo. This improvement will enable this organization to render more efficient service.

E. E. MAHER announces the formation of the Maher Engineering Co. with offices in the Michigan Boulevard Building, Chicago, to handle the sales and installation of power plant machinery.

RAYMOND G. SHERMAN has recently been promoted from the position of superintendent of the Deerfield River Power Co. to that of superintendent for the Connecticut River Power Co. Both companies are under the management of the New England Power Co.

J. W. MCCABE, who, until recently, has been district manager of sales for the Chicago Pneumatic Tool Co. at Buffalo, N. Y., has been appointed special representative for the company's foreign trade department and will depart shortly for an extended trip throughout the Orient, Philippine Islands and Australia. W. H. White has been appointed acting district manager of sales at Buffalo to take charge of that territory during Mr. McCabe's absence.

ON JUNE 14, 1919, at 7:30 a. m., an 85-hp. internally fired boiler exploded in the plant of the Des Moines Asphalt Paving Co., East 2nd St. and New York Ave., Des Moines, Iowa. Two men were slightly injured—one scalded, the other hit by flying debris. The building over the car on which the boiler was stationed, together with the engine, was totally wrecked. The damage is estimated at $500, not including the boiler. The rupture occurred at first girth seam (single riveted joint), some of the rivets shearing and the plate breaking clean in other places as though sheet had crystallized. Rupture extended about ⅓ circumference of 36 in. shell, thickness of plate 7/16 in. According to the statement of the man in charge, the boiler had been in use 15 to 20 yr., but had been retubed this spring and thoroughly cleaned. The boiler did not leave the setting, as it was bolted down securely to the car.

ON JUNE 27, at 8:00 p. m., there was held a review of seven moving picture electrical films prepared by the Society for Electrical Development and one by the Western Electric Company. For the special benefit of exporters, and by courtesy of the Bush Terminal Co., an exhibit was arranged at which these were shown, and to which also were invited prominent men of the industry in New York, Brooklyn, New Jersey and the members of the society in the Metropolitan district. Also there were in attendance newspaper men, representatives of the trade press, and the women household editors of prominent magazines. Among the films shown at the exhibit were: The Home That Runs By Magic, Santa and the Wonderful Genie, Which One of These Is You? Who Washes Your Clothes? Current Convenience, The Heat Chaser, Table Cookery, A Square Deal for Your Wife (Western Electric).

THE NAVY TECHNICAL ASSOCIATION, consisting of 700 civilian engineers in navy yards at Boston, Newport, Hartford, New York, Schenectady, Philadelphia, Washington, Norfolk and Hampton Roads, has been amalgamated with the American Association of Engineers. Final steps were taken by delegates of the Navy Technical Association at its convention in Washington, June 8-9, and the arrangement was approved by the National Board of Directors of A. A. E. at its meeting, June 14. A. A. E. waives entrance fee to members of the Navy Technical Association and continues branches of the league as adjuncts to chapters where formed as nuclei of chapters in the cities where none exist.

The American Association of Engineers has employed R. C. Bailey, President of the N. T. A. and formerly Expert Aide at the Brooklyn Navy Yard, as its Assistant Secretary in Washington. Offices will be opened there in the near future. Mr. Bailey will give practically all of his time for a while to the adjustment of the compensation problems of the members of the N. T. A., and will thereafter give attention to the broader questions affecting engineers which require Washington representation. Inasmuch as A. A. E. is launching a campaign in the interests of engineers in public service, government, states, counties and municipalities, it becomes necessary that a representative be placed at Washington.

RECOGNITION of demonstrated engineering ability is seen in the result of the recent election to the office of Mayor of Oklahoma City, Okla., of J. C. Walton, consulting engineer of the firm of Mackintosh-Walton Co.

Previous to this election, Mr. Walton was Commissioner of Public Works of the city, having charge of the department of engineering. The efficient manner in which his department handled the straightening of the Canadian River through the city, elimination of grade crossings, a Union Depot project, an intercepting sewer, a sewage disposal plant, and other municipal problems resulted in the choice of Mr. Walton as mayor when his term as commissioner was but half completed.

Mr. Walton still retains his engineering interests through his connection with the Mackintosh-Walton Co. and as president of the Oklahoma Chapter of the American Association of Engineers.

JOBS FOR marine engineers, paying from $143.75 a month for third assistants to $287.50 a month for chiefs, with board and quarters free, are actually going begging at Atlantic ports, according to a statement issued recently by the U. S. Shipping Board.

As an example of the shortage of engineers, it was stated that the Boston shipping agency of the board had 18 places for engineers open and no applicants. The marine engineers' organization at Boston, which usually is ready to supply men for employment, stated it had very few men available for the grade of chief and had 20 places waiting for first, second and third assistants.

Similar conditions are reported from New York and Norfolk. New steamers bound from the Great Lakes to salt water are held up at Montreal for want of engineers, which ordinarily are promptly sent from Boston to replace the lake engineers who take the vessel down the St. Lawrence to that point.

AT THE COMMENCEMENT of the University of Pittsburgh, the honorary degree of Doctor of Engineering was conferred upon Van H. Manning, of Washington, D. C., the Director of the Bureau of Mines, Department of the Interior, in special recognition of his activities in aiding the winning of the war. The presentation was made by Dr. Raymond F. Bacon, Director of the Mellon Institute, who said: "I have the honor and pleasure to present the distinguished Director of the United States Bureau of Mines, Vannoy Hartrog Manning, for the degree of Doctor of Engineering. This distinction is most appropriately conferred upon Mr. Manning in recognition of his leadership of all work on the conservation of our natural resources. Possessing the highest executive ability, an authority on mineral technology, Mr. Manning has rendered inestimably valuable service to the nation in the development of the activities of our world-famed Bureau of Mines and in demonstrating to our industrialists and legislators that research is the basis of national development."

THE WAR TRADE BOARD announce that shipments of coal may now be made from all ports on the Atlantic seaboard, and that the Collectors of Customs have been notified to disregard the provision contained in export licenses already issued to the effect that shipment must be made from Philadelphia or ports south thereof.

THE MONASH LINE of pressure reducing valves and pump governors, formerly manufactured and sold by the Monash-Younker Co., of New York and Chicago, has been acquired by the Harrison Safety Boiler Works, of Philadelphia. The purchase includes a stock of manufactured parts and valves, drawings, patterns, trade mark and good will. The Harrison Safety Boiler Works will manufacture and market the valves under the trade name "Cochrane-Monash," and will supply repair parts for valves now in use.

THE MIDWEST ENGINE CO., of Indianapolis, announces the opening of four offices in order to cope more fully with and meet the growing demand for its prime movers, pumping equipment, etc. Jacksonville, Fla.; El Paso, Texas; New Orleans and New York, are the locations selected.

Four well known and experienced men have been named to serve as managers of the new offices: D. J. Carrison, in the Florida Life Building, Jacksonville, Florida; Chester B. Loomis, in western Texas, Arizona, New Mexico and Southern California, with offices at 303 Caples Bldg., El Paso; B. H. Downing, Eastern Sales Manager, with offices at 111 Broadway, New York; and J. R. Lowe, at 617 Maison Blanche Bldg., New Orleans.

U. S. CIVIL SERVICE COMMISSION announces an examination for mechanical engineer in experimental work, for men only, July 29. A vacancy in the Engineering Experiment Station, Naval Academy, Annapolis, Md., at $8 a day, and future vacancies requiring similar qualifications throughout the United States, will be filled from this examination. The special duties of the position will be to conduct tests on mechanisms and other appliances constructed for use on vessels of the Navy, and to make adequate reports on such tests; and to prosecute research work that will be helpful to the designing division of the Bureau of Steam Engineering, Navy Department, Washington, D. C. It is desired to secure the services of a highly trained man with talent for experimental and research work. Apply for Form 2118.

Books and Catalogs

THE TIDEWATER OIL CO., 11 Broadway, New York, has just issued a 46-page publication called "Fuel Oil," in which the advantages of using the product as a source of heat are taken up.

After its present status has been considered, refining processes, and its advantages over coal are very forcefully brought out. The author recommends heavy rather than light oils for fuel purposes since they contain more B.t.u. per gallon, can be burned as efficiently and cost less. Oils having asphalt, paraffin and cyclo-napthene as various bases are particularly adapted for production of these heavy products. Ease and certainty of control are among the many advantages as well as the neat, inexpensive and efficiently operating equipment required for an installation.

Thirty illustrations and charts are embodied in the text each serving its purpose admirably.

As a practical treatise, the publication is very interesting and will prove of much value to the trade.

It may be had free by plant owners, engineers and managers.

AN EIGHT-PAGE BULLETIN, embodying specifications for the Copes system of boiler feed regulation has just been published by the Northern Equipment Co., Erie, Pa., convenient for filing. The bulletin discusses the following points: Principle of operation, heat storage, reduction of furnace temperature fluctuations and sudden load change, service performance, constant characteristic thermostat, control valve, standard dimensions and drilling.

THE NEW EDITION of the Jones "A-C" Catalog has just been published. It shows a large sectional reproduction of the stoker in operation with the fire shown in actual colors. Typical boiler settings are given under different types of boilers. Installations typical of the Jones automatic cleaning under-feed stoker are illustrated.

"HOW ARE YOU FIXED?" is the title of a booklet which can be secured free of charge from the Armstrong Cork & Insulation Co., Pittsburgh, Pa.